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MARCH • 35c *Monthly*

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March, 1961

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CARS AND DRIVING

- [Catching Drunk Drivers.....](#) 59
- [Knee-Pressure Steers This Car.....](#) 64
- [10,000 Miles in a Lancer.....](#) 78

SCIENCE AND INDUSTRY

- [Giant Kettle Desalts the Sea.....](#) 66
- [Model Runs to Test Big Trains....](#) 84
- [Science Laboratory on Wheels.....](#) 86
- [How a Self-Winding Watch Works](#) 96
- [In Front of a Shotgun Blast.....](#) 110
- [Why People Walk in Their Sleep..](#) 126

DISCOVERIES AND INVENTIONS

- [Tree Chopper Cuts 'Em to Size....](#) 92
- [What Should You Invent?.....](#) 112
- [Biggest Paver Has Three Bellies..](#) 118

SPECIAL FEATURES

- [History's Strangest Warship.....](#) 72
- [Cracking Safes for a Living.....](#) 88
- [Ticklish Job of Air Refueling.....](#) 98
- [They Bait Their Nets for Junk....](#) 106
- [9 Hints for Better Boating.....](#) 144

CONSUMER NEWS

- [What's New?](#) 122
- [Shop Report: Maximat Lathe.....](#) 152
- [Solid Wood in Big Panels.....](#) 163

PICTURE NEWS

- [Jet Does Down-to-Earth Job.....](#) 70
- [Newest Slot Machine.....](#) 77
- [He Carries Air on His Back.....](#) 87
- [Sub-Launched Landing Craft.....](#) 95
- [Lets the Sun Heat His House.....](#) 104
- [Stopping Speed in Its Tracks.....](#) 111
- [Fly-Off, Fly-On Sea Freight.....](#) 117

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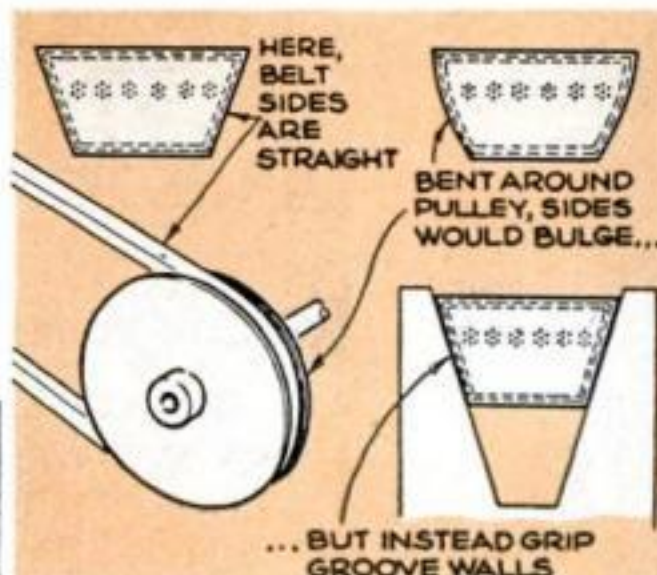
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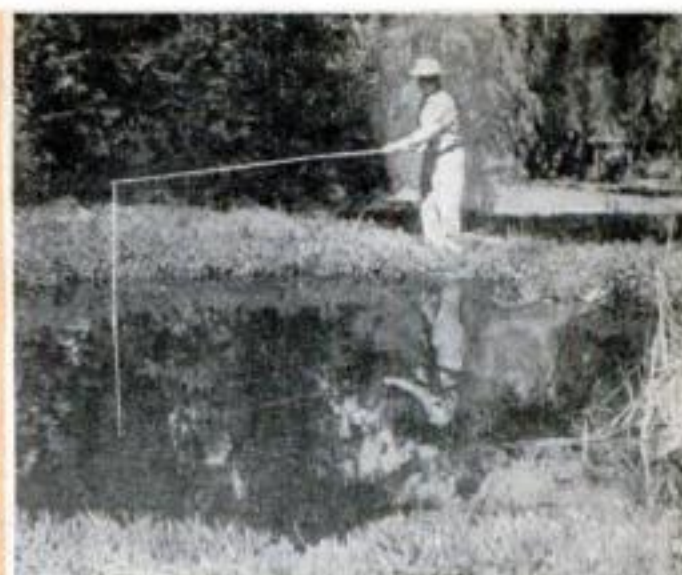
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High flyer. No fuel—
batteries run it. P. 129



V belts: A cinch to use
if you use them right. P. 135



Fishing: In your own back
yard? Here's how. P. 146

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HOME AND SHOP

Flying Electric-Prop Planes.....	129
Save-It File: V Belts.....	135
Motor Trike Roams the Hills.....	143
I Fish in My Back Yard.....	146
My Amazing Lean-To Scaffold.....	148
Short Cuts to Faster Shopwork....	156
A Lathe-Turned Jewel Box.....	160
Magnets by the Yard.....	167
What's Your Mechanical IQ?.....	183
Radio Controls for the Savannah..	185
Electric Motor to Drive Model.....	188
Short Cuts for the Camera Man....	190
Embarrassing Shop Moment.....	191
Putting Electric Eyes to Work.....	192
Old-Timer's Finishing Formula....	196

AUTO UPKEEP

Hints from the Model Garage.....	205
Gus Meets with Resistance.....	210

SHORT CUTS AND TIPS

Three-Way Emergency Light.....	155
Jig Cuts Glass Accurately.....	161
Signal Saves Trip to Mailbox.....	162
New Faces for a Lead Hammer....	165
Bar Signal for Night Latch.....	166
Wrench Is Substitute Clamp.....	166
Lap Board for Armchair.....	183
Car Jack Makes a Bar Clamp.....	183
Tumble-Drum Cleans Chains.....	184
Guard Protects Plane Blade.....	191
Clean-Up Basin from Sink.....	202

EVERY MONTH

PS Readers Talk Back.....	4
PS Puzzlers	18
The Month in Science.....	23
Detroit Report	56
I'd Like to See Them Make.....	91
New Ideas from the Inventors.....	101
Wordless Workshop	150

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Hooking a Pickpocket

"How Pickpockets Pick Pockets" [Dec.] reminds me of a country yokel who had his pocket picked when he went to the county fair. He was smarter than he appeared to be and before going to the fair again, he carefully sewed fishhooks around the inside edge of his hip pocket. Then he put his wallet, stuffed with paper, in the pocket horizontally so a pickpocket would have to dig deep. At the fair, it wasn't long before he'd caught, and had in painful tow, what was known in those days as a grifter.

JOSEPH OTT, Barto, Pa.

No Detroit in New Zealand

I AM an avid reader of PS although your American nomenclature often puzzles me. And your new-car articles hardly apply to a New Zealander.

Autos aren't junked here until they are over 30 years old, unless wrecked. Model A Fords, greatly in use, sell for about half new price. Ten years ago I sold a 1930 Model A Tourer, the engine once rebored, for better than new price. We have a motor vehicle for every 4.3 persons and all vehicles must pass a mechanical-fitness test every six months.

One of my office colleagues drove a 1923 Columbia four miles to work every day and kept it going by buying another one for parts. He recently graduated to a '29 Chevy; also runs a Morris 8. Another fellow drives a '34 Chrysler Airflow. He spent \$600 on the motor alone recently. The cheapest Chevrolet, made in Canada and assembled in New Zealand, costs \$6,000—about three years' wages. That's why we have to make them last.

KEN JAMIESON, Wanganui East, N. Z.

No Smoke, No Soot, No Electricity

WE AT Iron Fireman Manufacturing Co. were much pleased by the attention given to our new Custom Mark II furnace and boiler in the article "No Flame, No Smoke, No Chimney" in your November issue.

This article, however, referred to both of these units as "electric," while actually they are oil-fired and constitute what many say is the most important development in home heating equipment in many years. Users report not only exceptional comfort but fuel savings of from 20 to 40 percent. This economy is due to the fact that these units give complete combustion of fuel, without smoke or soot, and operate without chimney draft.

H. M. CUTSHAW, General Sales Manager
Cleveland, Ohio.

Look, Pop, No Tubes

THE letter about mysterious radio signals [Dec.] reminded me of an experience I had when radio first came in. I was using earphones at the time, and got up to answer the doorbell leaving them on. As I passed a table, the phone plug dragged across a bronze ash tray. I was amazed to hear the same musical program I'd tuned in on the set. I later applied the plug to the electric fixture and went on from there. The program was



coming in on everything metal in the house—including all the canned goods in the pantry.

FRANK JENNE, Poland, Ohio.

Brakes for the Big Ships

I HAVE my doubts about the value of those drag anchors for ocean liners

CONTINUED

"HOW A 'CRAZY RUMOR' GOT ME PROMOTED!"



What I overheard one morning shook me right out of a rut!

"Company's getting ready to cut back . . . bound to be layoffs," I heard them say. "Just another crazy rumor," I told myself.

Just the same, I took quick stock of myself that night. Came up with four good reasons why the company would keep me on:

- Three years' experience*
- Getting along with foreman*
- Turning out acceptable work*
- Prompt and dependable*

And four just-as-good reasons why they might let me go:

- Making no real headway*
- Others better qualified*
- Still rated "semi-skilled"*
- Needs special training*

I wasn't in trouble. But I sure wasn't "in solid" like I should be. That's when I made up my mind to enroll for training with I.C.S.

I picked I.C.S. because it's the oldest and largest with 257 courses. The training is quick and thorough. It's recognized by my company and accredited by the National Home Study Council. You study in your spare time and get personalized, practical instruction—know-how you can apply next day on the job.

That was a year ago. There have been two layoffs since then. While some of the others were just hanging on or being released, I was moving up. My I.C.S. training started something. Not only did it get me promoted (with a fat pay hike), but it put me in line for real advancement.

Don't wait for a "crazy rumor" to set you straight. Take out your "job insurance" right now. Mail the coupon and get full, free details on how I.C.S. has helped thousands, how it can help you. No obligation—and you get three valuable books *free!* (1) How to Succeed; (2) Catalog of opportunities in the field of your choice; (3) Sample lesson (math).

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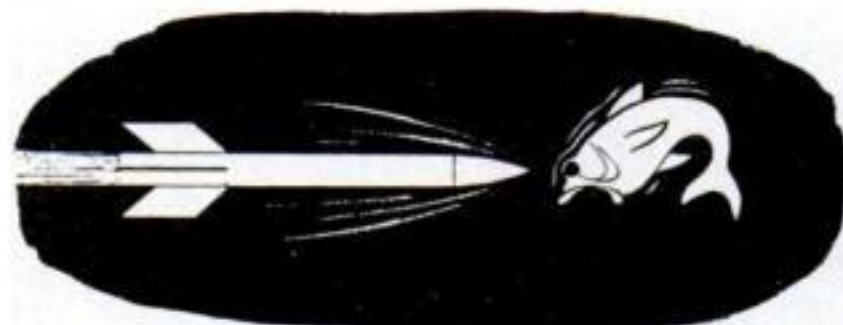
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6 POPULAR SCIENCE MARCH 1961

["New Ideas from the Inventors," Nov.]. It would take too many of them on a ship weighing several thousand tons and they'd lose effect as the ship slowed down. Also, if they were fastened to a high point on the ship, as shown, they'd come up out of the water. They'd have to be fixed at, or below, the water line.

I have my own idea for emergency brakes for ships: built-in rocket units on each side of the bow, under the water



line. The touch of a button would fire them, forcing the cover off their sealed compartment. The thrust would push forward against the water and hold the ship back.

SHERMAN ROBERTS, LaCrosse, Wis.

Green Grows the Carbonate

THE green color of weathered copper ["Copper Weather Vane in 3-D," Nov.] is due to a basic copper carbonate, not copper oxide as stated. This beautiful copper "rust" is due to the action of carbon dioxide and water vapor on the metal. Copper oxide may account for the blackening of copper left under water in some circumstances.

W. L. ORR, M.D., Ottawa, Canada

Short Sparks Reader Resistance

LIKE the Model Garage customer ["Gus Chases a Spook," Nov.], I'm wondering how a short from terminal block to hood can burn out bulbs. Wouldn't this have a tendency to shunt out the bulb and momentarily protect it?

Gus says a sudden voltage surge burned out the bulb. However, the short would lower the voltage and increase current; and, since the bulb has more resistance than the dead short, it wouldn't affect the bulb. Also, the headlights are connected in parallel and both would burn out if there were an increase in voltage.

AL SCHONNAGEL, Dakota, Minn.

... Gus's explanation doesn't seem right to me. The generator is a shunt-wound job with a resistor across the reg-

CONTINUED

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Name.....Age.....

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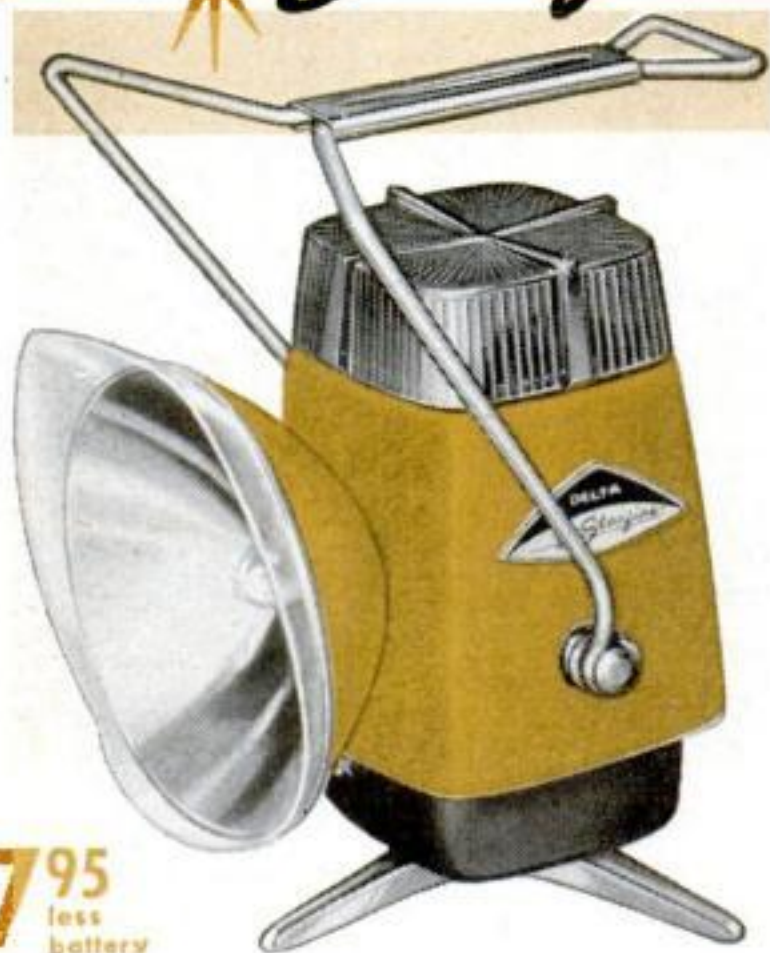
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Piercing spot lite. Brilliant flashing red lite.



Point the spot beam where you need it.



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For 50 years Delta has been the leading manufacturer of quality electric lanterns. Select your next lantern from the many models made by Delta. Write for free Fisherman's Calendar.

Delta

LIGHTS THE WAY

DELTA ELECTRIC CO., 325 W. 33rd St., Marion, Indiana

ulator contacts and a battery capable of taking a 50- or 100-amp jolt with ease. Now where does the surge come from at a particular spot like one head lamp, one tail light, or any other single spot?

I've heard lots of short-circuit tales, but most of them entail a blown fuse or a burned wire. Short circuits seek low resistance to do damage—easy going is a short's delight.

ALBERT HENRY, Salem, N.J.

A bulb burning out because of a short circuit is a painfully familiar fact to many auto mechanics. It does happen; and did happen because of a cocked terminal block in at least one instance we know of, as described by Gus.

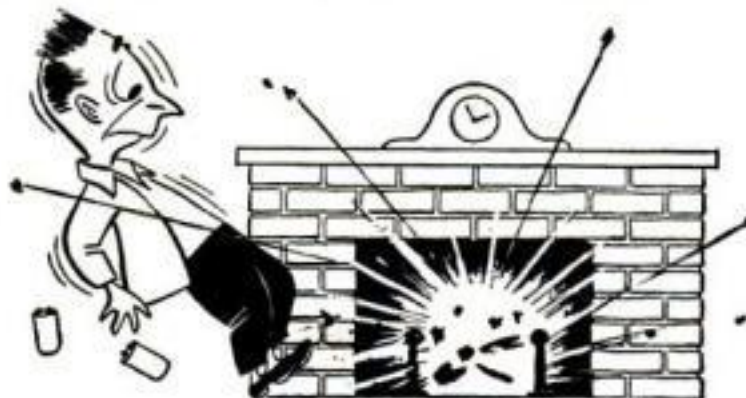
What distinguishes this kind of short from the ordinary permanent short is that it's momentary and the short circuit is broken sharply. It's the interruption of the short circuit that causes the surge. Since there is inductance in the circuit, the situation is electrically similar to the breaker points interrupting the flow of current through the ignition coil—the rapid collapse of the magnetic field generates a high-voltage transient.

Differences in age and make can account for slight differences in a bulb's ability to survive a momentary overvoltage.

Tip for Chimney Sweeps

How's your memory? When I was a kid, there was a generally accepted theory that the way to clean the chimney, or to keep soot from settling there in the first place, was to burn old dry-cell batteries in the fireplace or furnace.

Is there anything in this idea? I know one thing—you have to chop or break



open the shell of the battery or it will explode when it gets hot.

J. R. McCaffrey, Malibu, Calif.

This is an oldie, a dodge used when batteries were of the nonsealed type. The burning zinc was said to prevent soot



28 CARS WANTED IT! TEMPEST WON IT!

(Motor Trend's CAR OF THE YEAR Award goes to Pontiac's Tempest!)



The Motor Trend Magazine Car of the Year Award to Tempest marks the second time in three years that the Pontiac Motor Division has received this honor. The editors who selected it are (left to right): Robert Ames, Associate Editor. James Miller, Managing Editor. Don Werner, Editor.

These men edit one of America's leading car magazines—Motor Trend. What they know about cars can help you buy your next new car with complete confidence. They study all the different makes. Compare. Drive. Then they make one award for the year. The Motor Trend Car of the Year Award. This year these editors voted solidly for Pontiac's newcomer—the Tempest. The one car

that will give the car buyer top performance, ride and economy for his nickel. Read what these experts say!

Don Werner—"We studied the design features of 28 American cars. The Tempest pulled ahead of the whole crop of '61 cars. The flexible drive shaft is a fantastic innovation. It's the most sensible, dependable power train we've seen."

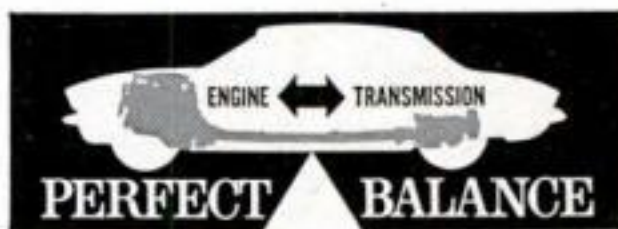
Bob Ames—"Equalizing the weight on the front wheels and the weight on the rear wheels (with the front engine/rear transmission) gives the Tempest great traction and ride. Pontiac engineers scored a great breakthrough with the Tempest."

Jim Miller—"The Tempest 4-cylinder engine and the triple alloy steel drive shaft team up as a smooth, going combination. I had to look under the hood to

convince myself they hadn't sneaked in a V-8. And that 4-cylinder engine should do wonders for gas economy."

Take it from this group of sharp automobile experts. They don't throw roses unless they mean it. Tempest took the Car of the Year Award because it's a winner. Check the facts! 110 to 155 h.p. from a gas-saving 4-cylinder engine! Big car balance = big car ride! Independent wheel suspension. Rear transmission. 15-inch wheels at no extra cost! Priced with the compacts. See your Pontiac dealer.

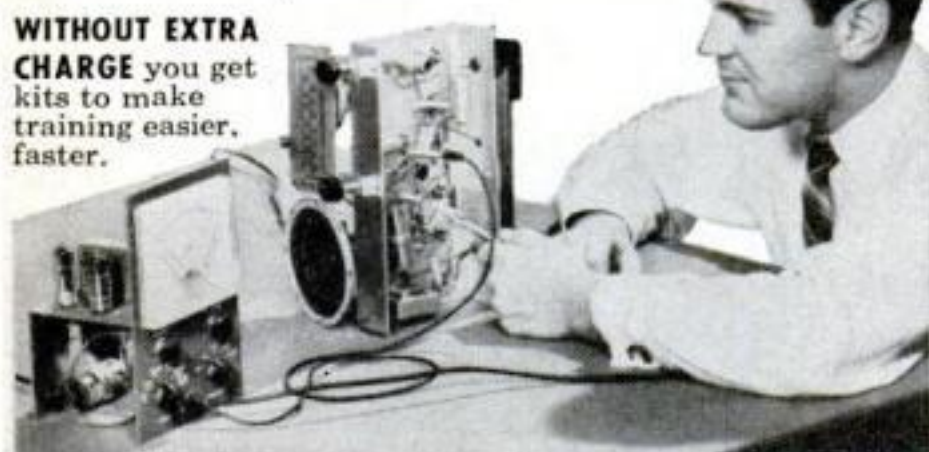
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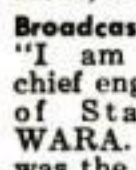
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Broadcasting.
"I am now chief engineer of Station WARA. NRI was the foundation." R. ARNOLD, Attleboro, Mass.



Industrial.
"Four months after starting your course I went to work at Raytheon. Now I am an engineering assistant in Microwave Power Tube Research." L. J. BLOOM, Newton Centre, Mass.

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formation. As you suggest, today's sealed batteries thrown on a fire will build up the gas pressure and explode.

S.O.S. to Camping Families

MY FAMILY read and reread "Here Come U. S. Minibuses" [Nov.]. We are camping fans and have been waiting for Detroit to put out a true sportsman's wagon—something plain but rugged and roomy. We could hardly wait for the local dealer to get his first Greenbrier—the Econoline still hasn't arrived.

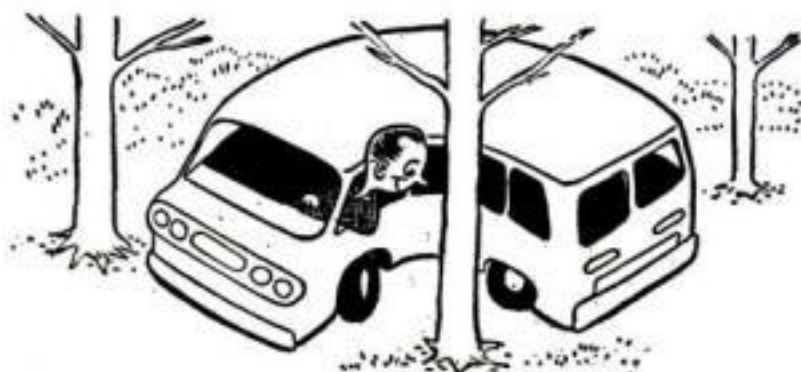
The Greenbrier seemed to fill all our requirements until we came to the problem of sleeping in it. We want to do away with loading and setting up a tent—especially in damp weather.

I have two boys plus my wife and myself to bunk down and try as I would I couldn't work out a decent arrangement. The bus isn't wide enough to sleep an adult crosswise and the step-down floor doesn't lend itself to bright ideas.

Perhaps some other reader can suggest how to solve my problem.

HERB KINNEY, Vallejo, Calif.

. . . You showed the Chevy Greenbrier turning circle as 19½ feet in diameter.



Since this figure is amazingly low, I wonder if some mistake was not made.

LEON DAVIDSON, White Plains, N. Y.

A mistake certainly was made. The figure should have been 39 feet, 2 inches.

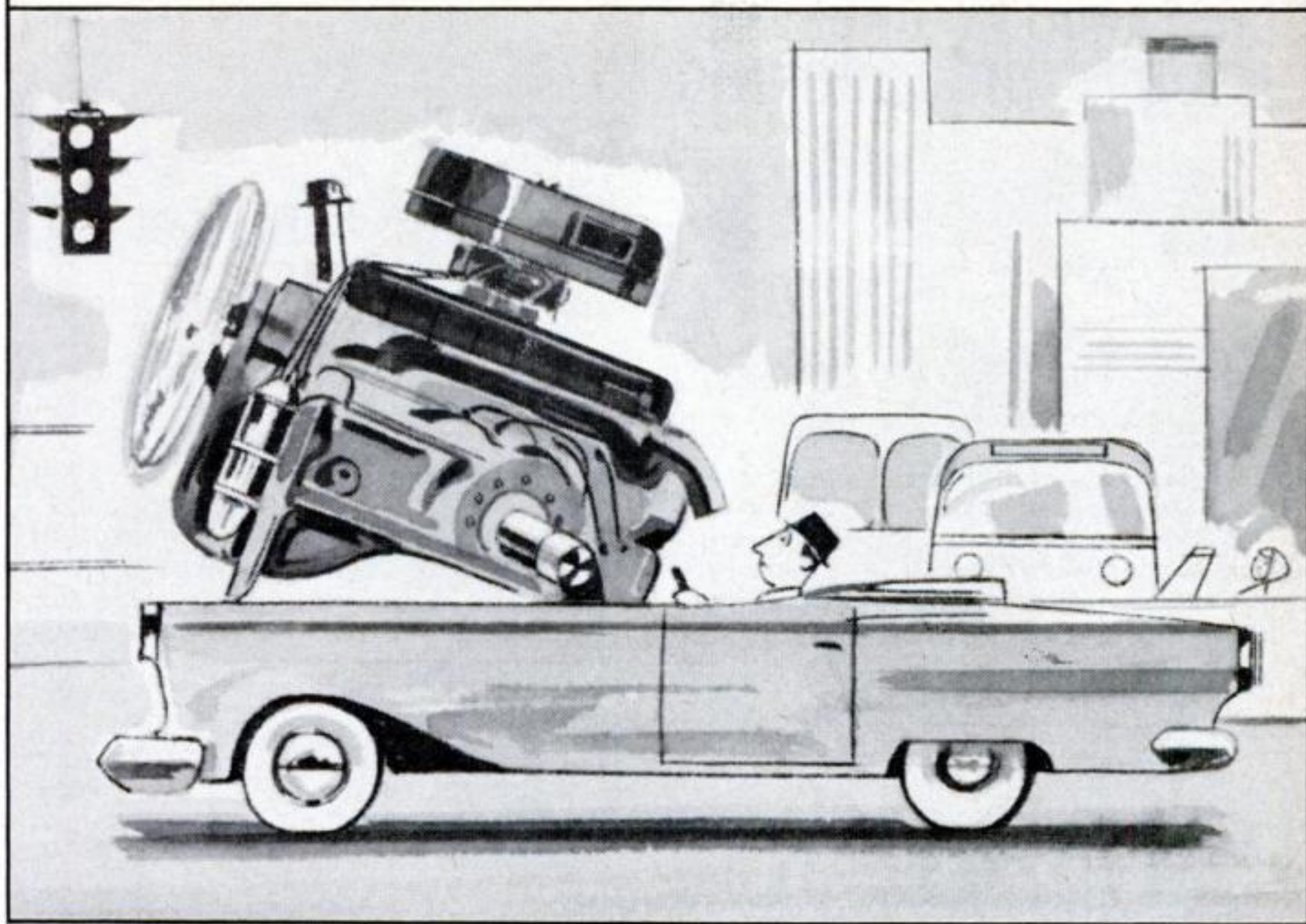
One Hit, One Error

ALTHOUGH I am a comparative novice at do-it-yourself projects, I know enough about gears to point out an error in the diagram on how a taxi meter works [Nov.]. The flag gears would never mesh as drawn because the teeth are at right angles to each other.

MYRON M. GELMAN, New Orleans.

Your eye has misled you: The eye judges the angle of the teeth in the upper gear by those visible on top. Those on the other side (the bottom, in mesh with

What to do about excessive driving costs . . .



50% of your driving time

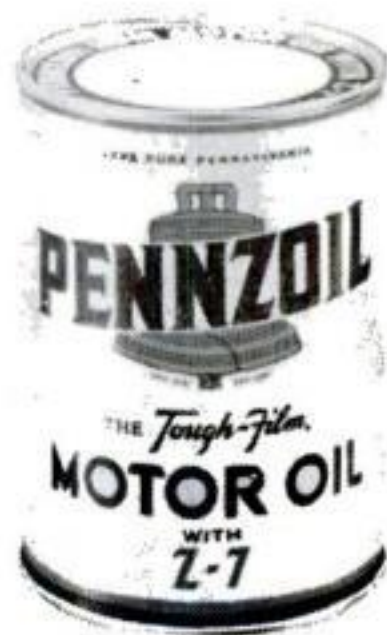
Your engine is too big for your car

“Easy” driving is hard on cars—actually costs you more! In traffic, for instance, you’re using only about 1/10 of your horsepower. That means incomplete combustion and gasoline waste—sludge build-up—excessive engine wear. Result: total driving costs skyrocket!

Using Pennzoil with Z-7 gives your engine the extra protection it needs in “hard”, low-speed, city driving—

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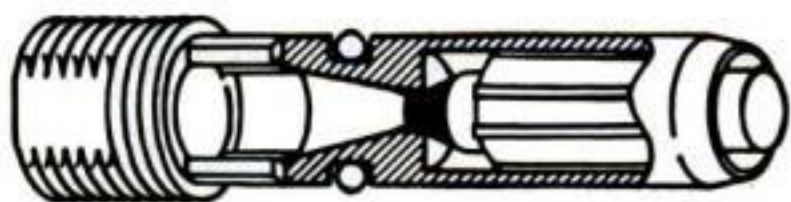
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C-6

11955 E. Nine Mile Road, Warren, Michigan

12 POPULAR SCIENCE MARCH 1961

the other gear) slant exactly the other—and correct—way. It's a pitfall draftsmen must watch for, and one our artist did not fall into.

... ARE you sure that taxi meter your artist drew is honest? The third of the fare drums, counting from left to right, reads 5, 8, 7, 8, 9. Whatever happened to the 6? Definitely, the fare's not fair on this meter!

LOUIS NICOLosi, Kansas City, Mo.

The artist must have been too intent on avoiding that pitfall above.

Knots—or Not?

ABOUT using a rope around a tree to pull a car out of mud or away from a wall ["What to Do When Your Car Gets Stuck," bonus booklet, Dec.]:

Why in heaven's name tie a knot in the rope, as the pictures show?

Wouldn't it be better just to pass the rope around the tree two or three times



and hold the loose end, to snub it? Then you could quickly and easily take up the slack each time the car gains ground—and spare yourself the effort of untying a strained and balky knot. (That's assuming you have a helper at the wheel of the car—as in the picture of the first of the three tricks.)

MALCOLM STEARNS, Chicago.

... How come you omitted what is historically the first, and practically the best advice: Get a horse!

DR. LESTER LANDO, Monsey, N. Y.

... You say: When stuck in sand, use the jack at center of the bumper and raise both wheels, then shove sideways. This would probably work but would be expensive. The bumper on many a new car would bend nicely right where the jack was.

G. J. WEBER, Buchanan, Mich.

Mower Vs. Cat

THE letter writer [Dec.] who warns against raising a power mower to clear leaves off a sidewalk because of danger to

CONTINUED

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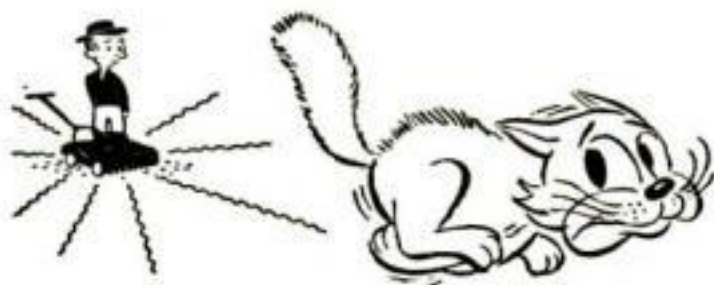


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Electronics in
SPACE TRAVEL

animals—especially cats—must have a different breed of cat in his neighborhood. My spayed female is about the bravest feline I've ever known. She even chases dogs off the place. But when I



start the mower she is careful to keep distance between herself and that noise.
W. B. SPEARS, Ecorse, Mich.

A Bit of Prop Wash

READING about the new six-bladed propeller ["Prop Changes Curve in Flight," Dec.] gives the impression that "high camber" or high pitch is more useful for takeoff and "mild camber" or low pitch for cruising. Of course, the opposite is true. Low pitch allows the engine to rev up more and develop maximum power for takeoff. High pitch is for cruising.

Whatever happened to the one-bladed prop that was developed about 1937? I

flew two lightplanes so equipped and performance was remarkable. Adjustment of pitch was completely automatic and the absence of the usual gyroscopic effect of the conventional prop was very noticeable. Most people stare in disbelief at the idea of a one-bladed prop.
G. A. VIEHMANN, New Providence, N. J.

You are right about pitch. We were talking about "camber," however. Camber refers to blade-surface curvature, and acts oppositely to pitch.

Pulling Out Dents

WHY use a football to remove a dent from a car door ["Hints from the Model Garage," Dec.]? Hunt up a plumber's plunger, push it hard against the dent for good suction, pull it away, and presto, the dent is gone. You may have to do this two or three times for stubborn dents, but you don't have to remove the door paneling as with the football.

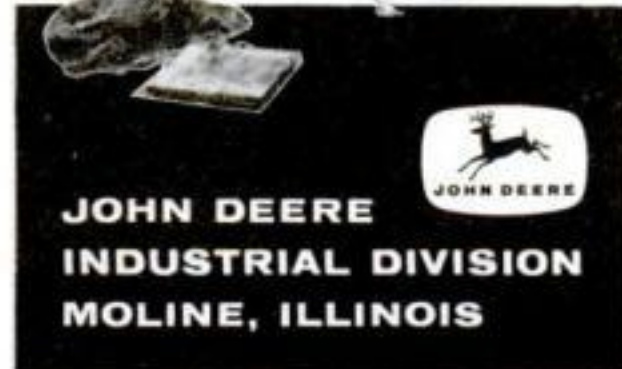
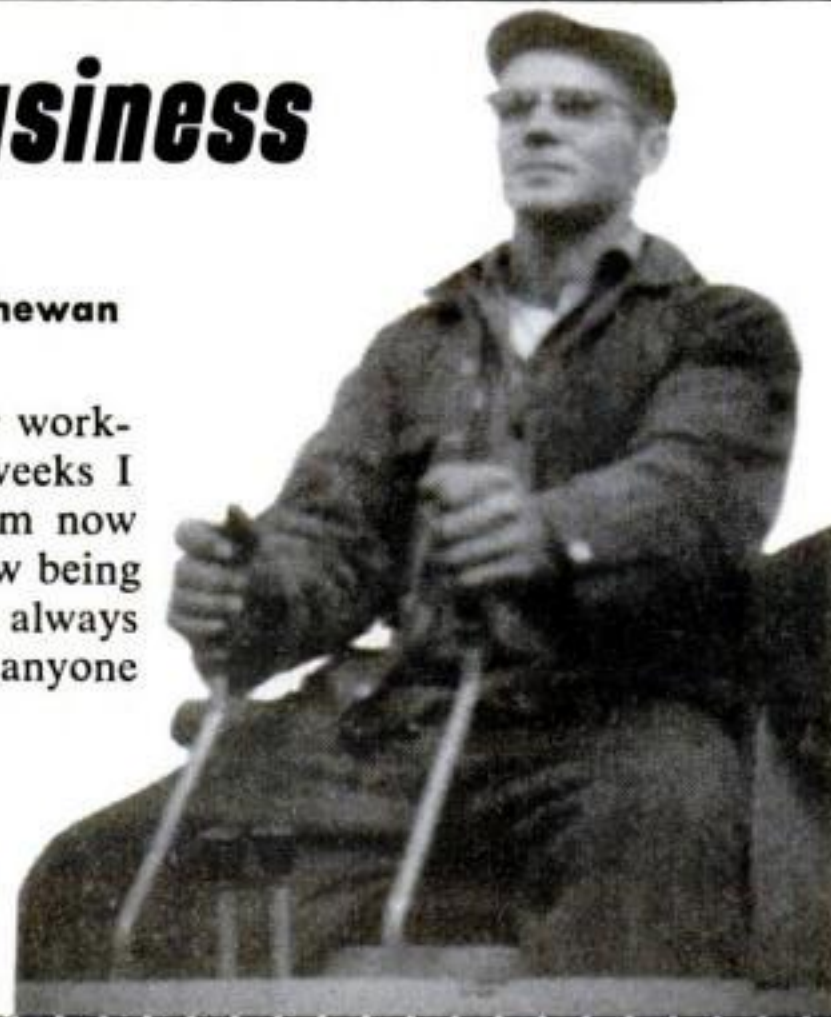
R. M. LEBLANC, New Orleans.

You and Gus Wilson must think along the same lines. See "Gus Tames a Tough"
CONTINUED

"I Built a Full-Time Business in six weeks"

says Jack Philip
Paynton, Saskatchewan

"MY JOHN DEERE BACKHOE was first bought for working after hours and on holidays. Within four to six weeks I had enough work lined up that I quit my job and am now working full time with the unit. With a lot of farms now being equipped with water systems and sewers, I believe I'll always have plenty of work. I would recommend this unit to anyone who wants to be independent and be his own boss."



Without obligation or cost to me, please rush information on John Deere Earthmoving Equipment, plus details of the John Deere Credit Plan.

Name.....

Occupation.....

Address.....

Dept. 2408



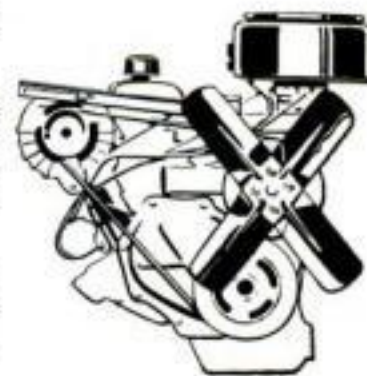
1961 Lancer

The best thing that ever happened to the 6-cylinder engine

When Chrysler Corporation developed the new Economy Slant Six Engine, they set it at a 30° angle for good reason—a bigger manifold system. This new design provides freer breathing, helps give you 20% more "go" on 15% less gas than our previous sixes.

A new, lightweight, 3-speed automatic transmission, the TorqueFlite Six, designed especially for the Economy Slant Six, gives the added pep of a torque converter, plus the smoothness and economy of a third forward speed.

This new engine and new transmission are available in Plymouth and Dodge Dart models, with smaller versions in the Valiant and Lancer. Let a drive bring out the difference great engineering makes.



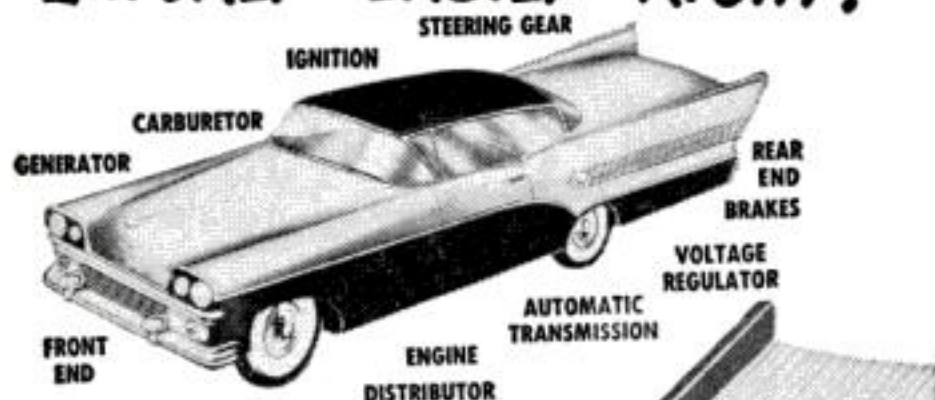
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Bird" [Jan.] and you'll find that he, too, used a "plumber's helper"—to remove a dent in a gas tank.

Neutral or Hot?

I ENJOYED "Why Ground Electric Systems?" [Dec.] but it left me wondering about one thing. You say: "To maintain the identity of the conductors throughout the system, the [National Electric] Code requires that the neutral always be a white wire. The hot wires must be black, or some color other than white or green."

I wonder what the Code says about switch wires. Often when we wire lights with switches, we run the hot line into the junction box that the light will be fastened to. We then run Romex to the switch box, using the white wire as the feed to the switch and the black as the return to the light.

This has been acceptable to both the REA and the Missouri Power and Light Company. My boss says we do this to allow us, or anybody else, to identify switch wires in a box later on. Does the Code approve of it?

R. E. HENLEY, New Cambria, Mo.

The Code makes a specific exception for switch legs, allowing the method you describe.

Making Any Folk Toys?

MAY I add a hint to folks interested in making "The Folk Toys We're All Forgetting" [Dec]? That paper boat you talk about will float better and longer if



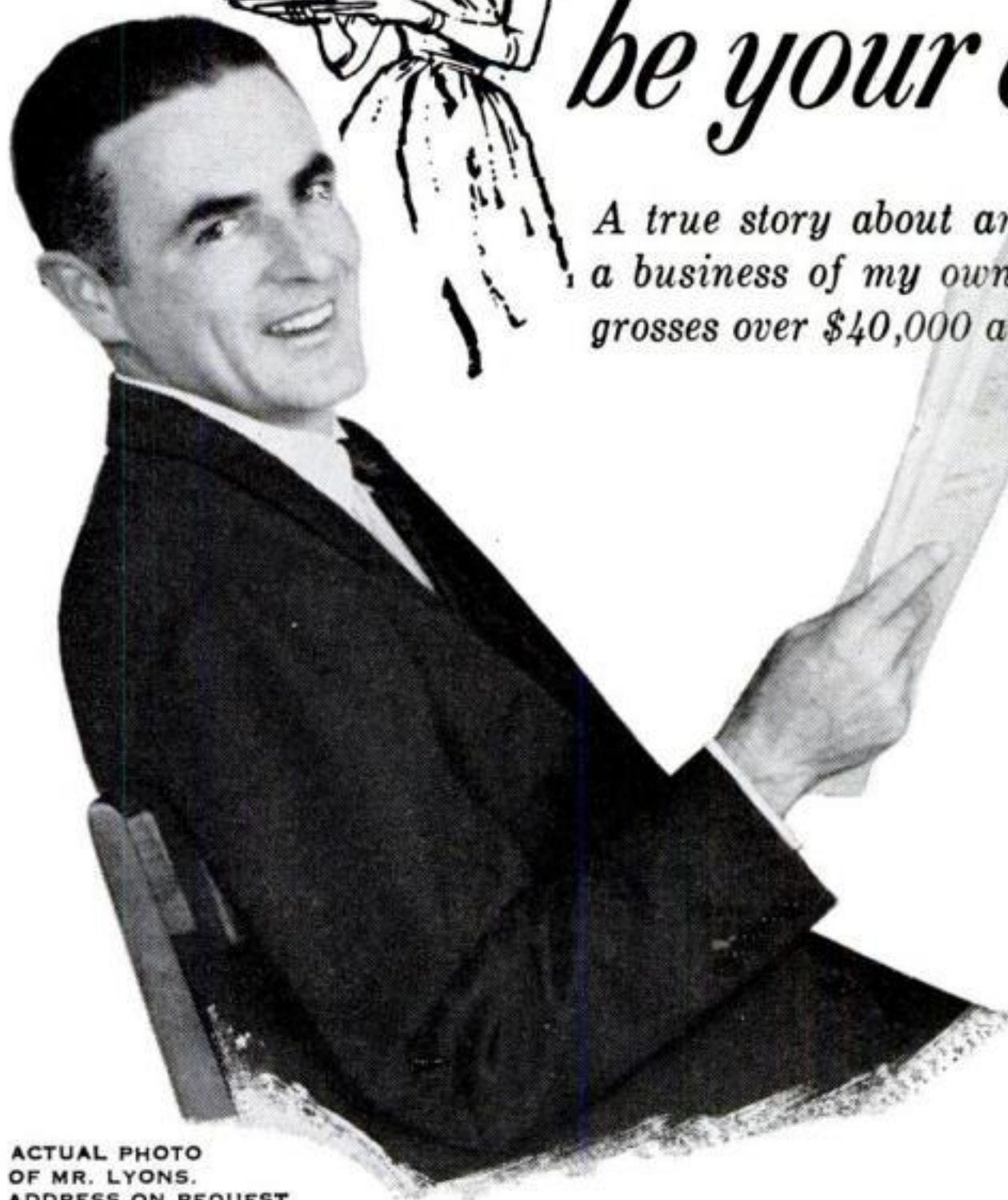
you color the bottom with a wax crayon after making it.

LESTER MILLMAN, Rye, N. Y.

Don't Plan a Long Cruise

You say you can't use decals on a watergoing sub model ["Stripping a Kit Submarine for Action," Nov.]. I undertook one of these stripping jobs and it worked out fine, but I'm not much when it comes to art work. So I put on the decals, let them dry, and then varnished them. So far, they're waterproof.

TOM FRANKEL, Bayside, N.Y.



ACTUAL PHOTO
OF MR. LYONS.
ADDRESS ON REQUEST.

Gosh, it's good to be your own boss!

*A true story about an ad that got me started in
a business of my own three years ago—that now
grosses over \$40,000 annually!*

Easy to Get and Keep Customers

Your success in this field is charted with a tested sales program set up by the company. First, it teaches you how to *get* customers. And when we get customers, we *keep* them because of Duraclean's fine advantages. Folks rave most over our no-scrubbing, no-soaking features which mean rapid drying and no-shrinking or texture distortion.

6 Ways to Make More Money

Money-making opportunities are not only in cleaning. You have 5 other services: soil retarding; moth-proofing; spot removal; minor carpet repair; flameproofing... and 15 home care products to sell, at a nice profit.

Security a Grand Feeling

As I start my fourth year as a Duraclean dealer, I have a profitable repeat business—satisfied customers who keep coming back for more!

If you're looking for this kind of opportunity, write Duraclean, as I did. They'll send you the facts free. No one will call on you until you *ask* for personal advice. Just fill in the coupon—this may be *your* big chance, too!

Backed by 3 famous awards

Mail coupon today for free booklets!

DURACLEAN COMPANY
1-183 Duraclean Bldg., Deerfield, Ill.
Please rush FREE booklets which detail how I may own my own business. I understand I am under no obligation and no salesman will call.

Name.....

Address.....

City.....State.....

by Michael J. Lyons

It sure is a wonderful feeling to be your own boss and know the sky's the limit if you're willing to get in and pitch. I know, for I've been on both sides of the fence.

I'd been watching for just the right thing when I spotted an ad offering a Duraclean rug and upholstery cleaning dealership.

Now, just three years since I saw that ad, I have my own \$40,000-a-year business.

I investigated the company and found it to be a top level firm respected in the field since 1930.

Unlimited Market Potential
I found that the money-making pos-

sibilities in this field are endless. The Duraclean process itself—its safety and efficiency—told me that here was the right combination to make it BIG.

Easy to Start—Training Free
It's easy to get started with Duraclean. Everything is provided—and a complete training course helps you build your new business.

You don't need a shop since cleaning is done in the customer's home or place of business. And with wall-to-wall carpet so popular, "on location" cleaning is really a *must!*

PS Puzzlers By Joan Steen

Some riddles to ruin your rest . . . Answers on p. 238



How's Your Average on Average Speeds?

TO QUALIFY for the Spring Sports Car Meet drivers have to complete two laps around a mile track in two minutes for an average of 60 m.p.h. Dick got off to a bad start and averaged only 30 m.p.h. on the first lap.

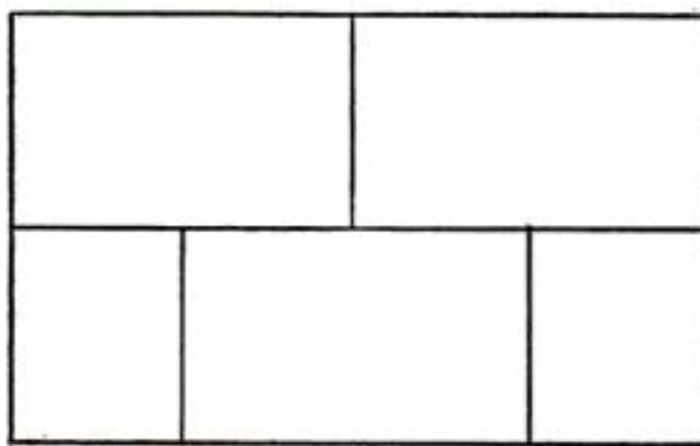
That's all right, he thought. I can easily floorboard this buggy to 90 m.p.h. the second time around—and I'll still

qualify for the speed run. Did he?

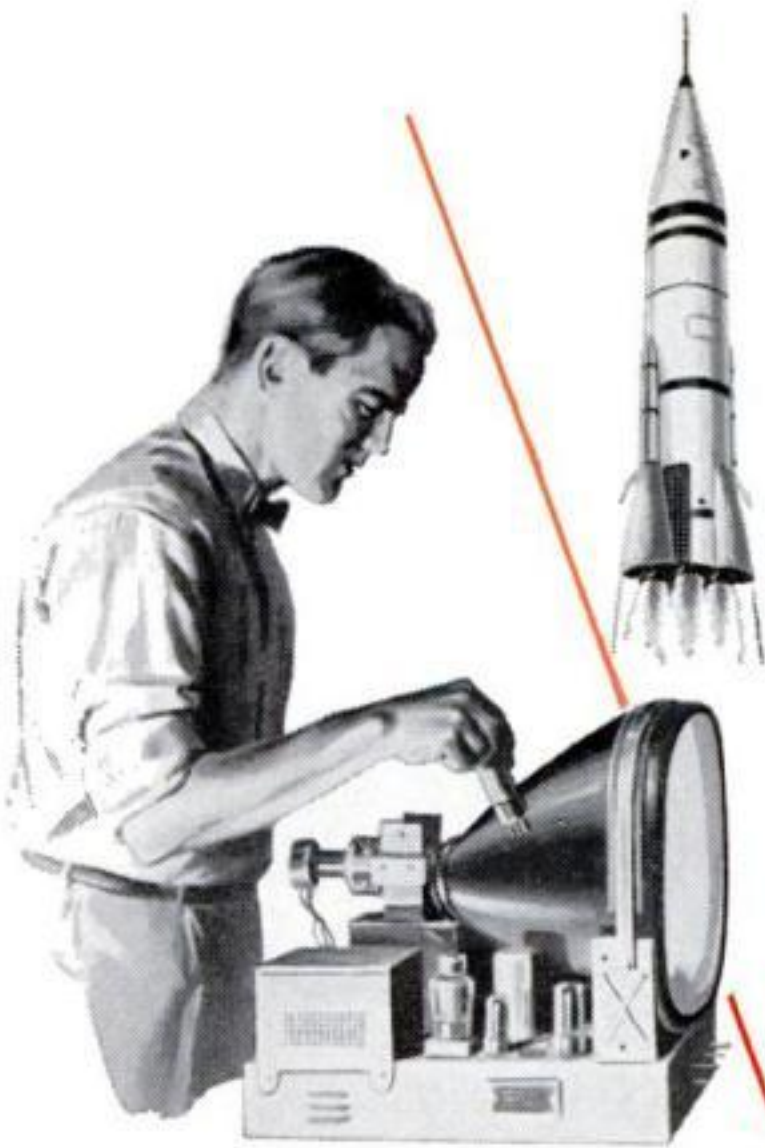
If that's too easy for you, try this: Crosstown traffic is particularly bad one morning and you average only 10 m.p.h. from the bridge exit to your office building. Going home, traffic is a little better—you cover the same distance at 15 m.p.h. What's your average speed for the round trip?

IT'S just an ordinary design—like paving bricks. But it caused me an extraordinary amount of trouble. The solution is wholly satisfying, however. Even if you give up, you feel you've been dealt with fairly.

The rules in this "unicursal" puzzle are traditional: Without lifting pencil from paper, trace a line that crosses each different line of the rectangle without recrossing any of them.



HOW often have you reached into a box of nails and picked out a bent one? Enough to be annoyed, I'd guess. Have you ever thought how the probabilities work out? Suppose a box contains 100 nails and there are 10 defectives. What would you say the chances are that out of 10 nails you select at random, none is defective? One in ten? Less?



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PS Puzzlers continued

NOW let's see if we can catch you on a few fast ones.

1) Two amateur numismatists—coin collectors—met one day. "I've a real find," exclaimed one, "a copper penny marked George I."

"I'm no pro," said the other, "but you sure got rooked." How did he know?

2) It shouldn't take you too long to take four 9s and with simple arithmetical signs arrange them to add to a 100. But can you do it with four 7s?

3) Homer supposedly died of fury and frustration at not being able to solve this riddle posed to him by some fishermen he met one day. "How many did you catch?" he asked. "As many as we caught, we left," they answered. "As many as we did not catch, we carry."

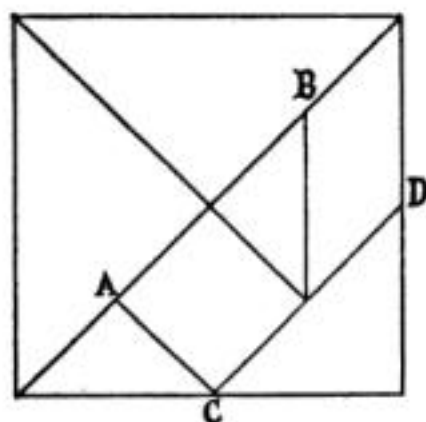


Puzzle of the month

I WAS wondering how to amuse a friend in the hospital the other day when I thought of "Tangrams"—the old Chinese tile game that had once seen me through a restless convalescence. The basic seven figures are easy to cut from cardboard and the game is simply to reproduce given patterns us-

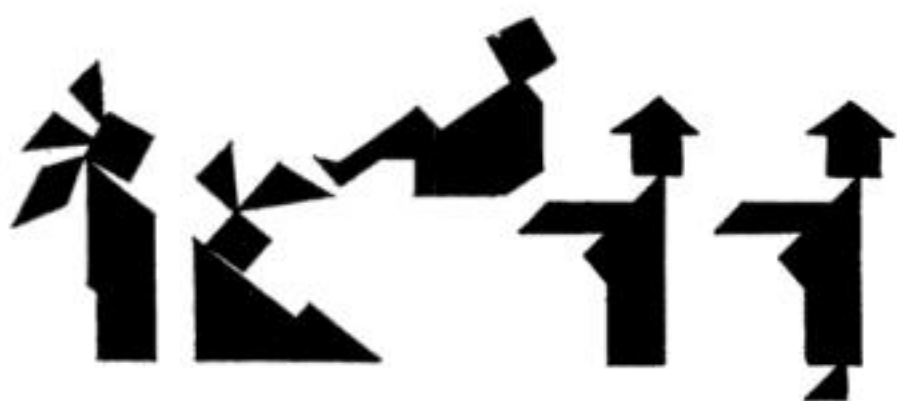
ing all the pieces (with no overlaps).

The possibilities are endless and all good Tangramers (sick or not) sooner or later make up their own. How to cut the magic seven is shown. The designs come from such eminent puzzlers as Sam Loyd and Henry Dudeney who deserves credit for the seemingly paradoxical pair. (Answers next month.)



How to cut the Tangram

Start with a square. Points A and B are mid-points of semi-diagonals, C and D of sides.



Answer to last month's P-O-T-M: There are 12 pills in a bottle. All weigh the same except one which is either lighter or heavier. You are to determine in three weighings on a scale balance which is the odd pill and which way it's off-weight.

The trick is to divide the pills into groups of four. Then, numbering them, there is a set of three weighings that takes care of all possibilities:

- 1) 1, 2, 3, 4 vs. 5, 6, 7, 8
- 2) 1, 2, 5, 9 vs. 3, 6, 10, 11
- 3) 1, 4, 7, 10 vs. 2, 3, 11, 12

For example, suppose the first weighing is balanced, and the second weighing heavy

on the 1, 2, 5, 9 side. Putting both facts together you can deduce that this can only happen if 9 is heavy or if 10 or 11 is light. (The others must all be regular.) The third weighing will pin it down for you. If 1, 4, 7, 10 balances 2, 3, 11, 12, then 10 and 11 are both regular so 9 must be heavy. If the third weighing is not balanced, then either 10 or 11 is light depending on which way the scales rise.

If 12 should turn out to be the odd-weighted pill you will know automatically which way it's out at the third weighing: The two preceding weighings will have established that all other pills are of regular weight. Similar reasoning works in all other cases.

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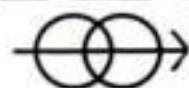
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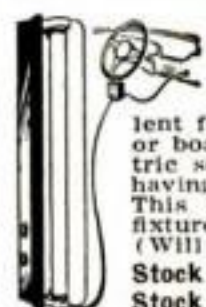
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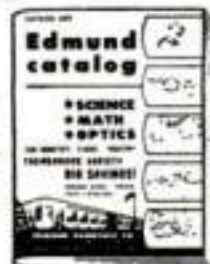
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The month in science

Now hear this, IBM 704. Everybody talks to machines. It is well known that selected profanity will arouse a balky engine. Every time you dial a telephone number, you talk to a machine.

When you talk to the telephone system, you have to use its native tongue, electrical pulses. That's not hard, since 100 pulses, at the most, will get you practically anybody in the U.S. But if you want to do something more involved than ringing up Aunt Minnie in Oscaloosa—like designing an airplane wing or solving problems in quantum mechanics—you need a smarter electric brain than the phone exchange. The native tongue of these high-IQ robots is binary code, a two-digit number system that 10-fingered people find clumsy (the number 13 comes out 1101). So automatic computers have been taught the decimal system (they convert decimal to binary in their transistorized heads).

Yet even this is not enough, reports Robert Sanford in the United Aircraft publication *Bee-Hive*. Talking to computers in numbers takes too long and causes too many errors. You can't afford to waste time or make mistakes on a machine that rents at the rate of \$5 per *minute*.

Now the brainiest of the brains have been taught crude versions of English. (Russian computers presumably talk Russian.) You can't actually speak to them (no ears). You send them telegrams.

The computer is hooked to a teletypewriter on which you bang out orders in the appropriate dialect. If the machine understands IBM Commercial Translator, for example, here's how to tell it to calculate overtime, social security, and income tax for a payroll:

COMPUTE. PAY. IF DETAIL HOURS IS GREATER THAN 40 THEN SET DETAIL GROSS = (DETAIL HOURS - 40) * MASTER RATE * 1.5. SET DETAIL GROSS = DETAIL GROSS + MASTER RATE * 40, DO FICA. ROUTINE, DO WITHHOLDING. TAX. ROUTINE.



One reply to misdirection

The machines talk back the same way, printing out their replies in English on the typer. Some of these literate robots have been endowed with college-type wit by their mathematician masters. One machine reacts to wrong instructions by blinking its neon-red eyes malevolently and printing out **YOU IDIOT, YOU IDIOT, YOU IDIOT.** Another, programmed to speak the MAD dialect (for Michigan Algorithm Decoder), cries tilt by printing out a typewriter picture (above) of *Mad* magazine's comic character, Alfred E. Neuman, complete with motto.

Conversational ability is one clue to machines' intelligence. The British mathematician Turing said (in 1938, before the first digital computer had been built) that a real thinking machine could carry on a conversation with a man in another room—and the man

The month in science continued

couldn't tell if he were talking to a machine or another man. Some new computers almost pass this test. Here's an excerpt from a man-machine chat about the weather:

Man: In hot weather one needs at least one bath a day.

Computer: Yes, I was just out and it was sweltering.

Man: When Christmas comes we will have some colder weather.

Computer: Cold? Yes, it's usually pretty frosty during December.

The robots haven't quite taken over yet, though. Robert Sanford points out that no computer dialect includes the word "think." The machine wouldn't know what to do.

More light for less money. What sounds like the biggest improvement in light bulbs since Edison's day has been invented by Luke Thorington, research director for the Duro-Test Corp. of North Bergen, N.J. Still in the development stage, it is a combination incandescent-fluorescent that looks like a movie-projector lamp, screws into a standard socket (no starter), and should cut home electric bills sharply.

Ordinary incandescent lights, while pleasing and convenient, throw away a shocking amount of electricity—90 percent of the watts they consume becomes annoying, unilluminating heat. Now Thorington has conjured up a neat trick for converting that waste heat into light.

His combination bulb contains a hot (4,000 degrees F.) tungsten filament, like an incandescent, and a thin coating of phosphor chemicals (zinc silicate and manganese) inside the glass, like a fluorescent. The bulb is filled with a little hydrogen gas (instead of the nitrogen-argon used in incandescents, or the mercury-argon used in fluorescents). The hydrogen is the trick.

The hot tungsten breaks the hydrogen molecules apart into their two component atoms. The divorced hydrogen atoms zip over to the phosphor surface, where they hitch up into molecules again. This recombination releases a hefty wallop of energy that is just right for nudging the phosphor atoms into fluorescing with useful light. Then the hydrogen molecules can go back to the filament to be split apart again.

This filament-to-hydrogen-to-phosphor triple play, Thorington figures, should deliver three times as much light for every watt consumed as present incandescent bulbs do. You'd light your house on one-third the electricity you use now.

Space hi-fi. Historic signals from man's first space explorers (including the heartbeat of Laika, the dog orbited by the USSR) are now available for playback at home. They were recorded by Prof. Thomas A. Benham of Haverford College from Sputniks I and II, Vanguard I, and Explorers I, II, and III.

Accompanying the signals is a commentary by Professor Benham that explains their meanings. Price of a 10-inch LP record or 7½-inches-per-second tape is \$3.95 from Taben Recordings, Box 224E, Ardmore, Pa.

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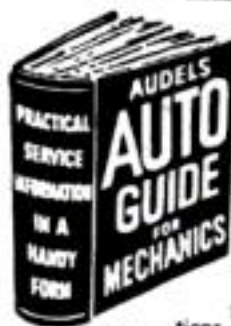
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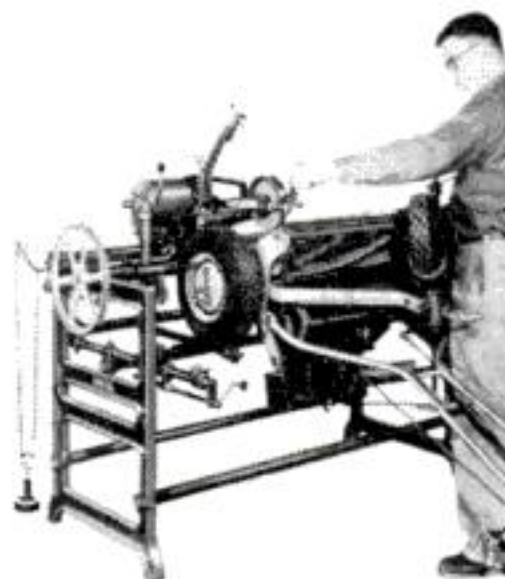
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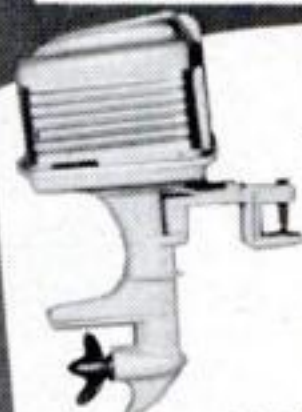


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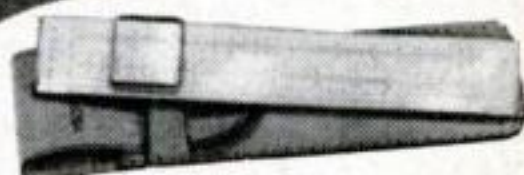
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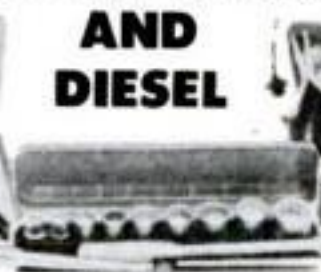
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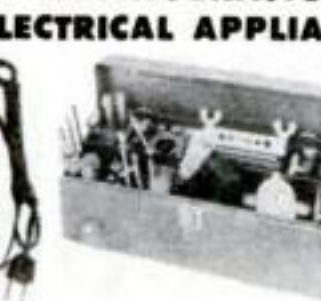
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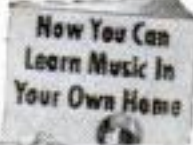


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(AS TOLD TO PAUL STAG)**

Here is how I catch more fish than I ever caught in my life before. . . . More fish than I ever dreamed of — and **BIGGER** fish than I ever suspected possible. Here is how you can catch bass, pike, perch, bream, trout, salmon, crapple, pickerel, walleyes and many, many other kinds of fresh water game and pan fish plus many salt water fish . . . the same way I do.

Since I invented my fishing lure, I catch so many fish, such **BIG** fish, and catch them so **FAST**, people gather to watch me. I've been followed **FOUR TIMES** in **ONE** day by a fish warden to find out if my methods are legal. But my entire secret is my fishing lure that's **GUARANTEED** to **CATCH FISH** — or it costs you nothing. Yes, **GUARANTEED** to catch fish even when other lures or even live bait fails or no cost.

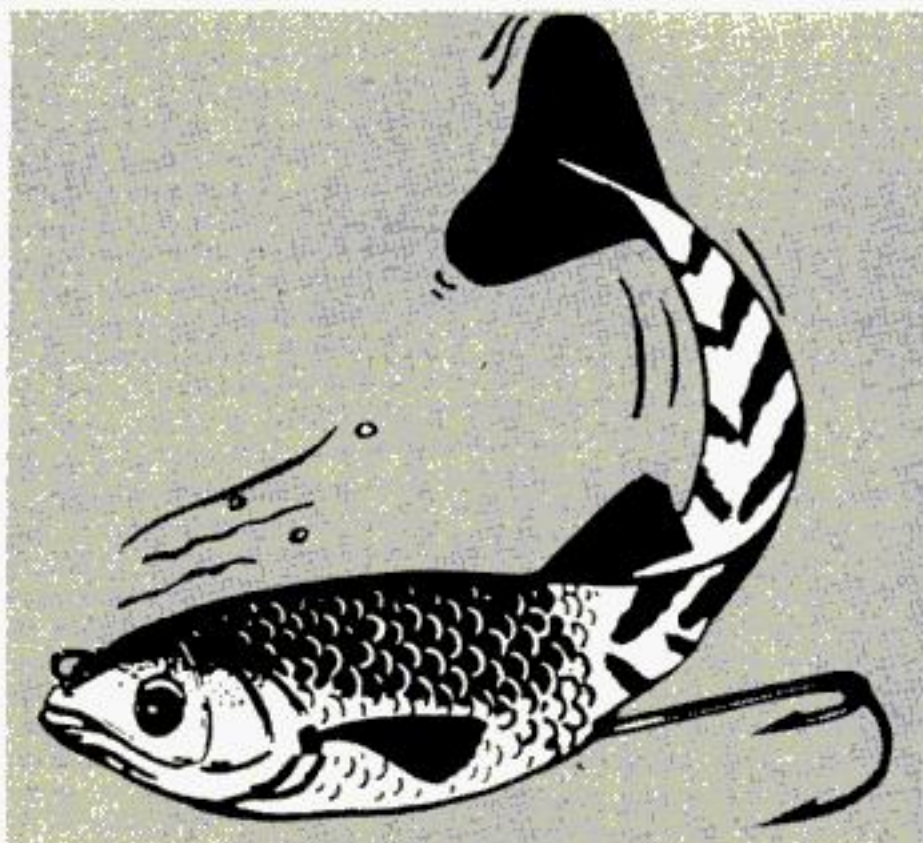
My lure works in lakes, ponds, streams, salt water, saves you time, work, money and disappointment, is ideal for amateurs, experts, trollers, casters, shore fishermen. My lure catches fish differently from anything you've ever seen before in fresh and salt water. Even veteran U. S. fishing guides have been surprised at its astonishing catches. And the French Government itself has certified my lure by actual patent as **UNIQUE!**

An Underwater Discovery

I am a Frenchman, a science teacher, a skin diver and I have fished all my life. For years I have studied fish underwater — **WHILE FISHERMEN ABOVE WATER** were trying to catch them. What I discovered changed every idea I ever had about fishing and fishing lures.

Lures Can Frighten Fish Away

I watched **UNDERWATER** exactly how fish reacted to every lure, live bait, every fishing maneuver and trick used to catch them. I watched fish approach even the best performing lures, seem **ABOUT TO STRIKE** — then suddenly **TURN AWAY**. Something about even the best performing lures was obviously often **KEEPING THEM FROM CATCHING** fish. As for the average lure, mostly they seemed actually to **BORE** the fish — as though they looked to the fish as they looked to me **UNDERWATER** — shiny, painted bits of metal, plastic and wood. I saw live bait after it was cast turn white and die before my eyes — and saw fish often approach, prepare to strike — **THEN TURN AWAY**.



HOW VIVIF WORKS!

Fish have never seen anything like this lure before. It attracts fish by its vibrating tail. It is the world's most life-like lure in the water. Fish can't resist it . . . and when they grab the lure it "feels" lifelike — doesn't warn them to spit it out before you can sink the hook in! Read this article and learn the amazing story of this imported lure.

Minnows Irresistible

Then I saw the same fish approach actual live swimming minnows and without caution or suspicion **STRIKE RAVENOUSLY**. I saw the same fish that rejected the lures again and again attack without caution **LIVE SWIMMING MINNOWS**. In fact, these little minnows seemed to **DRAW** many fish from a distance—even before being seen.

Why Lures Often Fail

My talks with fish scientists and my own studies convinced me it was the swimming motion of minnows, particularly the swishing tail that attracted many fish. I concluded that no lure I had ever used had **SUFFICIENTLY** duplicated the living minnow and its motion.

How, I asked myself, could a fish lure be created that would attract fish just as the actual living swimming minnows did — and that once attracted would get the same ravenous **STRIKE** as live minnows — **WITHOUT** the hesitation, suspicion and **FEAR** aroused by the lures I saw used?

My Man-Made "Minnow"

After 19 years of study and testing, I have finally created such a man-made "minnow," so like a living, swimming minnow in shape, form, texture and motion that fish ravenously **STRIKE** — without caution — and I catch more fish, bigger fish — and faster than ever before in my life.

Because my man-made "fish" looks, darts, wiggles, even "feels" like a minnow . . . bass, pickerel, pike, perch, trout and many other kinds of fresh and salt water fish attack voraciously — without suspicion or fear — even when they're not biting for another fisherman on the lake.

Astonishing Catches Reported

I call my lure VIVIF. Once I perfected VIVIF I started selling them to other fishermen. Soon news of astonishing catches came in — first France — then from other countries.

Yes, from all over comes reports of amazing catches — of fish biting where other lures failed — of the sureness, the simplicity, the effectiveness of this VIVIF lure. And what does this mean to you?

Simply this. Now YOU can get more out of fishing than ever before. Now YOU can catch more fish, bigger fish than ever in your life. It is **GUARANTEED** — or you pay not one penny. It means now no longer need you come back with an empty creel from a long day's fishing. It means no longer need you spend hours of work digging worms and catching minnows or other bait. It means you can save the endless expense of continually buying expensive spinners, flies, plugs, bait and lures. It means you can often catch the fish that are not biting on worms, bugs, plugs, spoons, canned bait, flies, cut bait or spinners or no cost. It means you can troll, cast, or shore fish with my lure with equal success. It means you can go out after and come back with large mouth bass, small mouth bass, pike, pickerel perch, bream, trout, walleyes, salmon, red tuna, striped bass, blue fish, weak fish and do it time and again — or your money will be refunded at any time. VIVIF is catching fish in 25 countries for delighted fishermen. 1,050,000 VIVIF's have been grabbed up. Already reports from U. S. fishermen say VIVIF is the greatest lure they have ever used. I predict VIVIF will soon be the world's fastest selling fish lure. But test the magic power of VIVIF yourself without risking a penny.

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All you do is mail amazing no-risk trial coupon. When you receive your VIVIF, use it anywhere you like . . . to prove its fantastic fish catching powers. Use it to catch bass, trout, perch, pickerel, pike, walleyes . . . any sport or pan fish you like to catch.

Put VIVIF to every test. If you don't agree it is the finest lure you've ever used . . . if it doesn't catch more fish and bigger fish, you have used it entirely free. It won't cost you a penny.



THIS IS EMILE PLANES, Science Instructor, Skin Diver, ardent fisherman from Beauce, France, who went underwater to find out why fish reject certain lures and chase others . . . and who, as a result of years of observation, research, and development, finally created a true-to-life man-made minnow that practically no fish can resist . . . that holds an all-time Char Trout record in Britain, and has made amazing catches in this country and all over the world. Read on this page how you can try this amazing minnow that's **GUARANTEED TO CATCH FISH OR IT COSTS YOU NOTHING!** Read amazing trial offer below.

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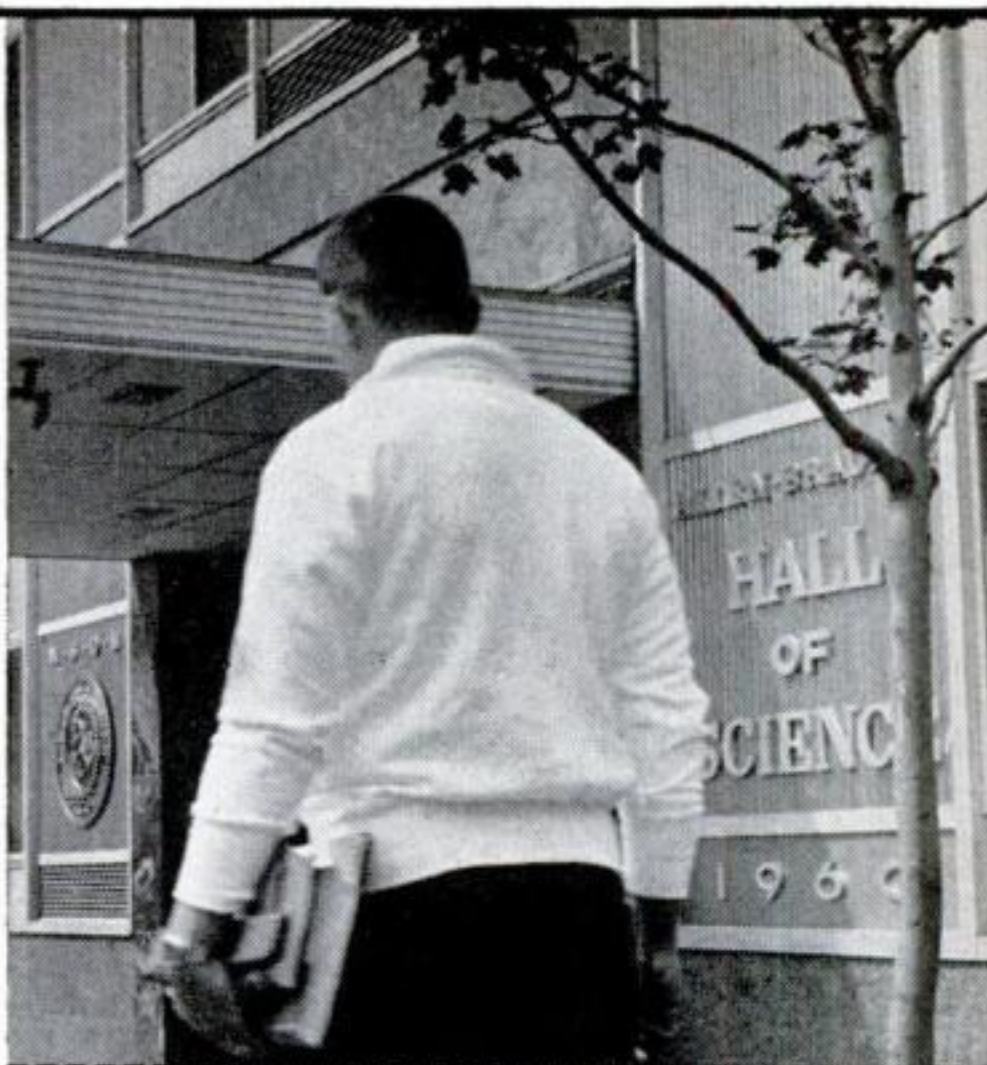
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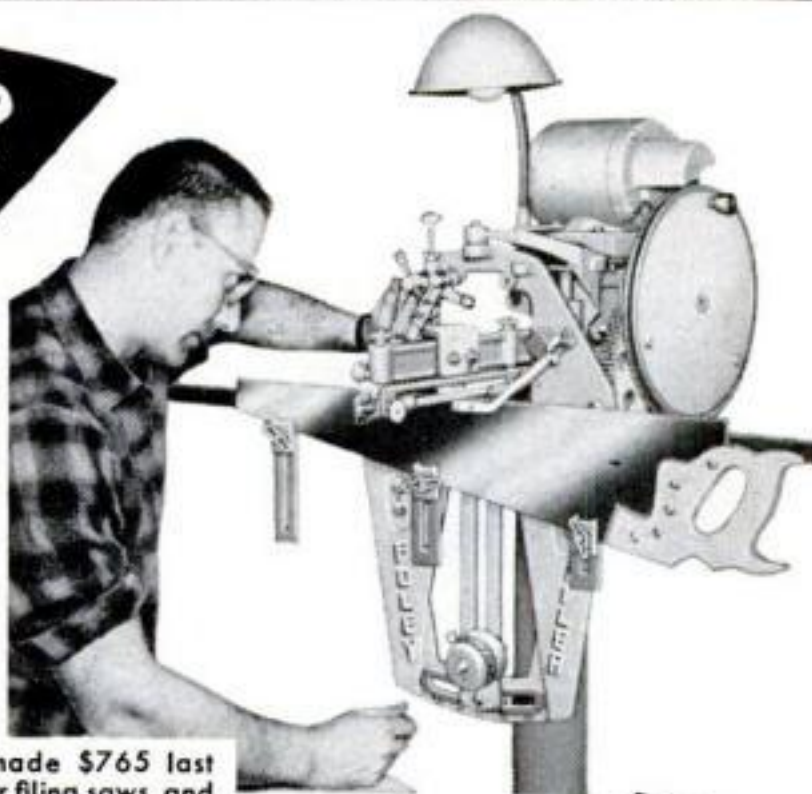
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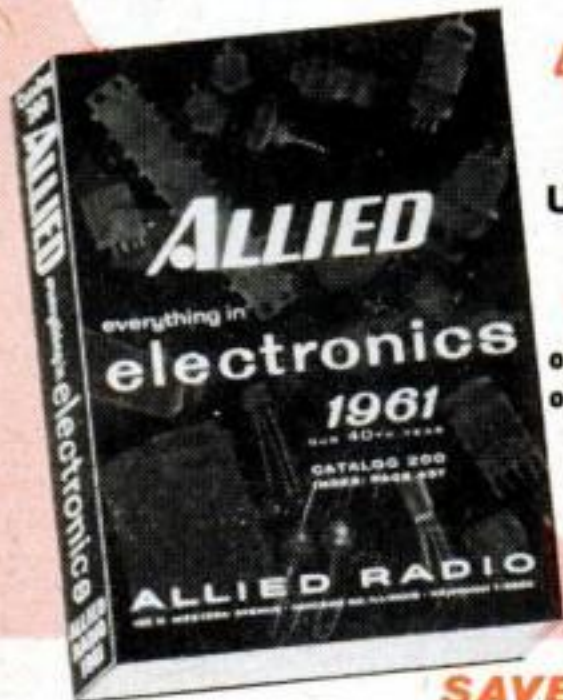
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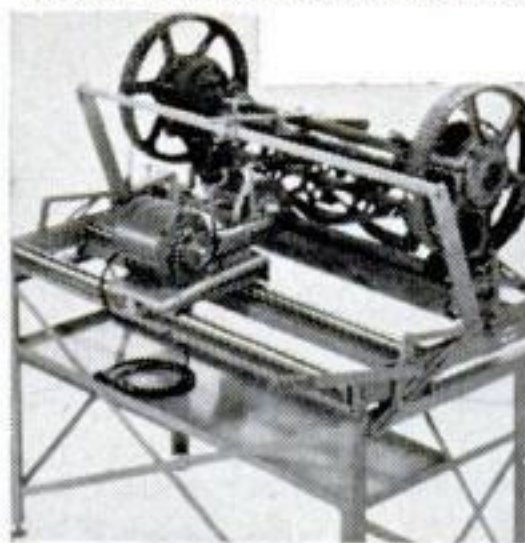
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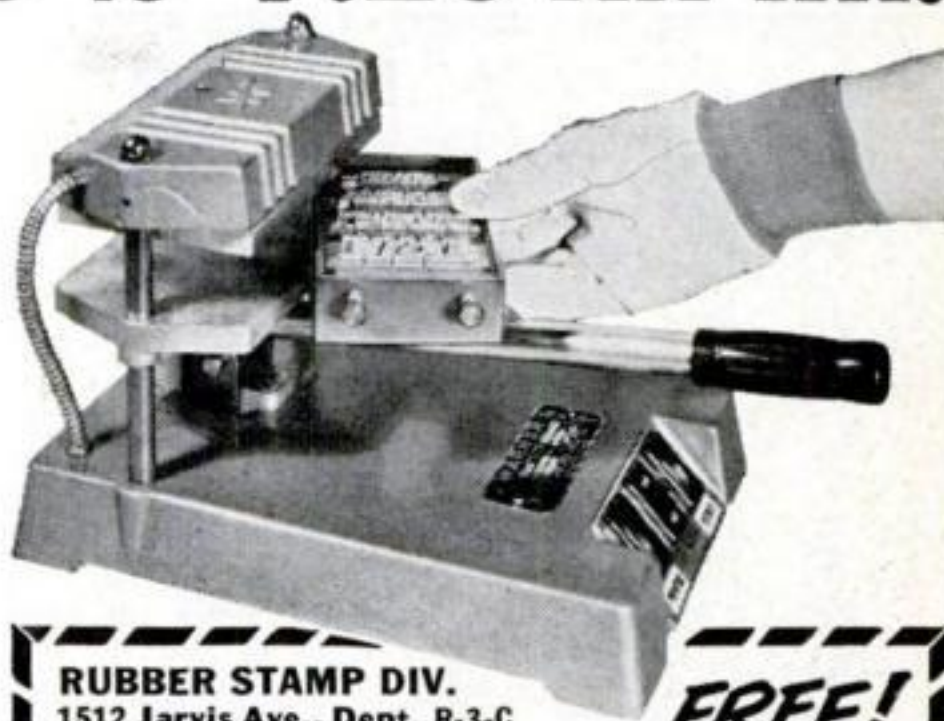
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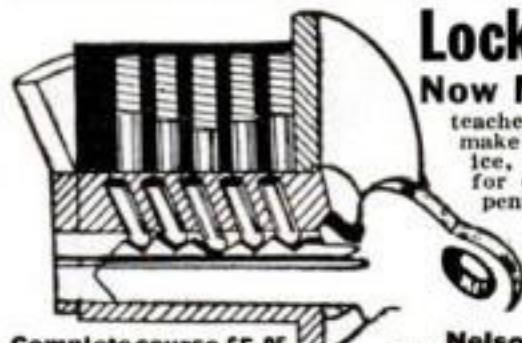
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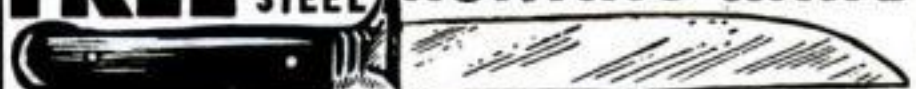
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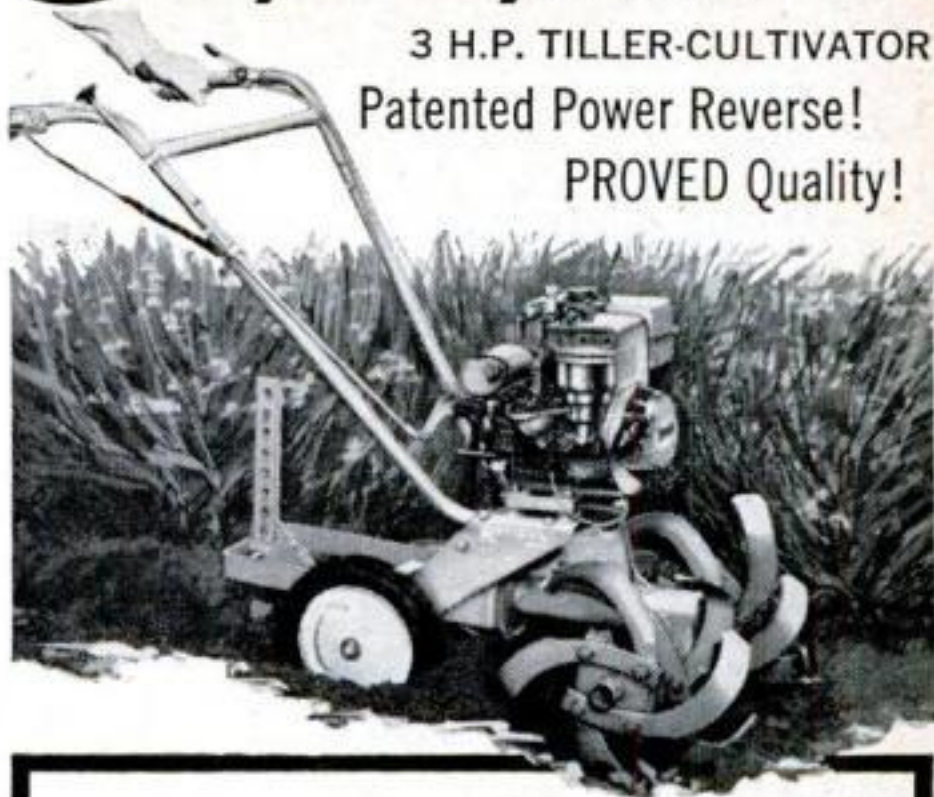
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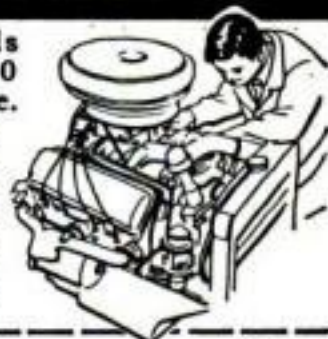
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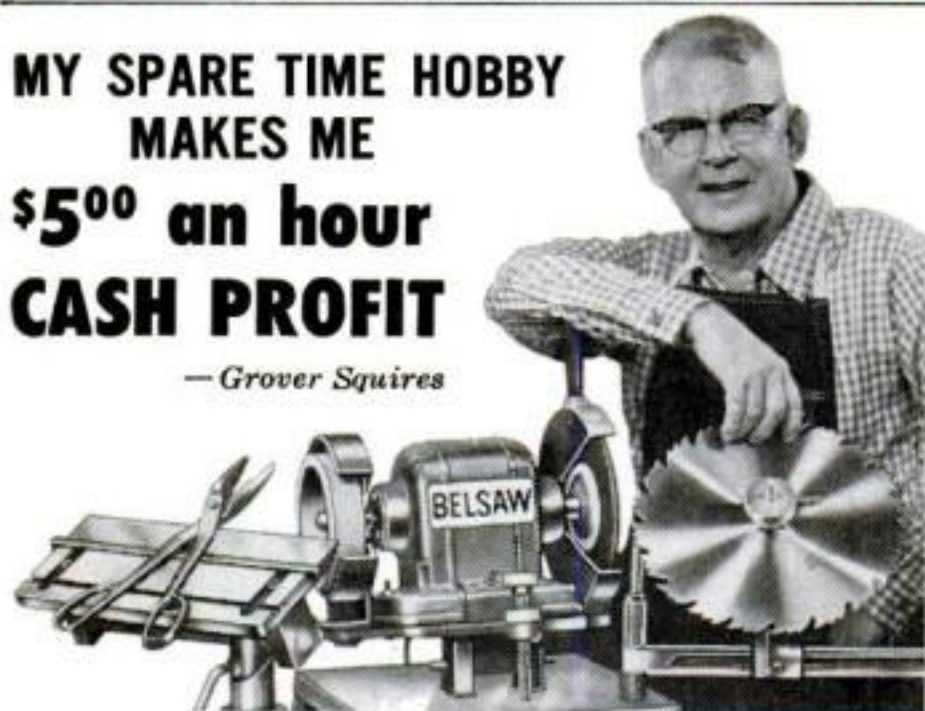
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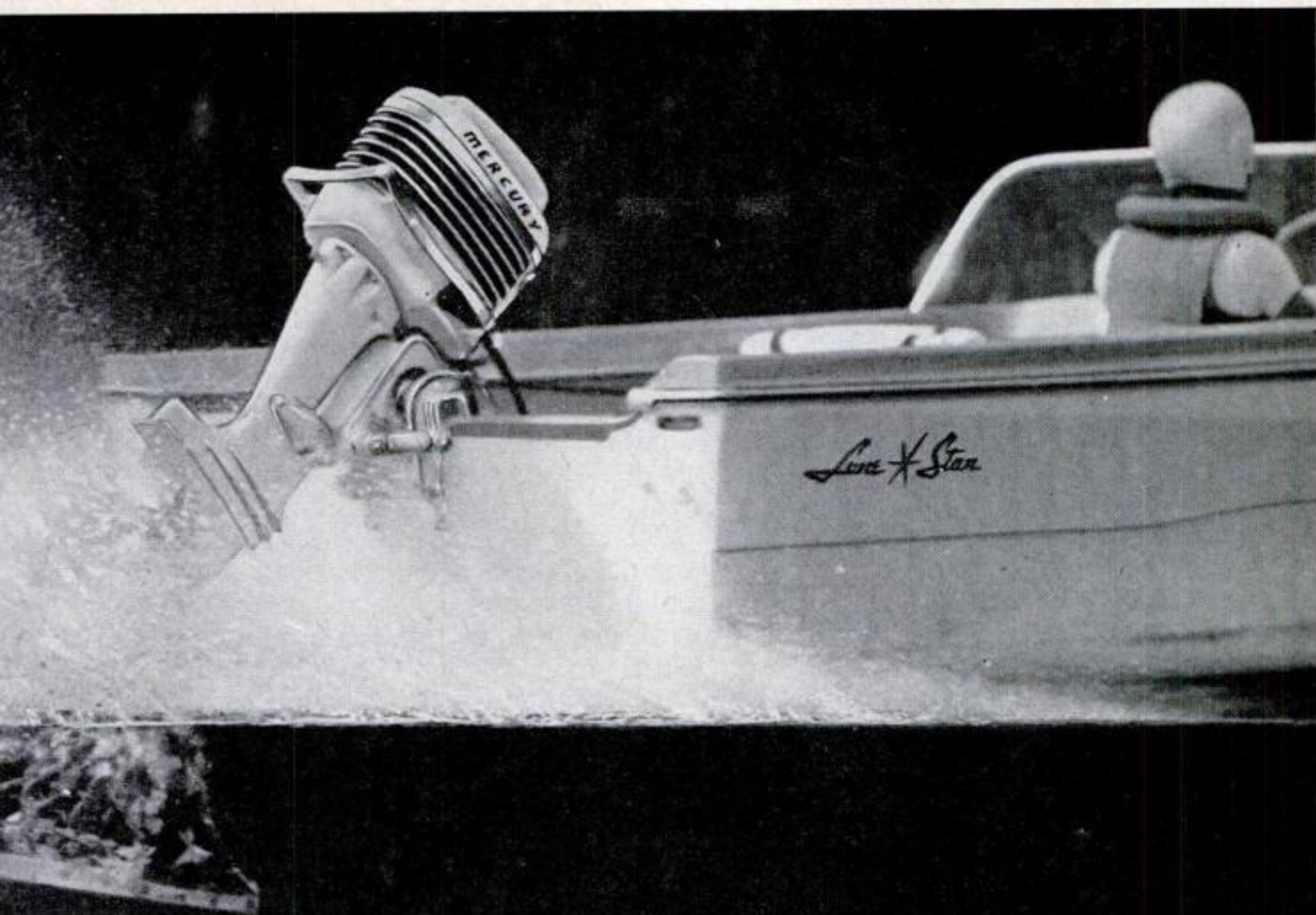
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STREAMLINED DESIGN of lower unit is hydrodynamically correct for maximum efficiency. No protruding nose to hook weeds and underwater objects.



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WHERE OTHER OUTBOARDS LEAVE OFF... MERCURY TAKES OVER!

Next: U. S. Cars in Three Sizes?

TOOLING orders placed recently by Ford and Chevy back up earlier rumors that both plan to offer bigger-than-compact but smaller-than-standard cars next fall.

The prototype of the Ford is about 197 inches long, has a 115-inch wheelbase, and weighs about 2,800 pounds. That makes it about a foot shorter and 1,000 pounds lighter than the current full-size Ford, and about a foot and a half longer and 400-500 pounds heavier than the 1961 Falcon. The new job will not replace either of those, but will cut into the number of full-size Ford models to be produced.

The new Chevy reportedly will have a 114-inch wheelbase, two inches longer

than the B-O-P compacts, with which it is expected to share some body tooling.

A 244-cu.-in. V-8 being tested at FoMoCo's Arizona proving grounds may power the in-between Ford. The prototypes of this engine have experimental sand-cast aluminum blocks; but if the engine does go into the new model, it will be with a cast-iron block.

The new Chevy may get a new six-cylinder engine, but its design is difficult to pin down. Most "usually reliable sources" are betting on a no-nonsense short-stroke OHV in-line. The long-shot types think Ed Cole, Chevy's boss, may have a V-6 up his sleeve. In either case, the engine will probably have a cast-iron block, like its Ford competitor.

Compact compact gets shelved.

Plans to bring out a short-wheelbase, four-cylinder small car for '62 have been canceled in South Bend. Instead, Studebaker will put its money into restyling the compact Lark and Lark Cruiser.

Reason for the decision: The market

for compacter compacts is too uncertain in this country to warrant the tooling expense at this time. Studebaker prefers to try to strengthen its position in the proven compact-car field and let other manufacturers do the pioneering and take the risks with smaller cars.

Aluminum engines hit snag. Unexpected casting problems apparently will delay the introduction of several new aluminum-block engines in 1962 cars. Buick and Olds won't bring out the big V-8s with aluminum blocks in their full-size 1962 cars, as originally planned. Cadillac has put its aluminum V-8 on the shelf. Chevy may bring out a new six for '62 (see above), but will make it of iron, not aluminum.

Ford has never been enthusiastic about aluminum blocks, and is even less so now. Chrysler continues to cast some of its '61 slant-six blocks of aluminum, but may not be able to boost output high enough to switch over completely to aluminum for the sixes in 1962.

The trouble? When molten aluminum is poured into molds at production-line speeds, the finished engine blocks tend to

be porous and to have "hard spots." The porosity was expected. Insiders say foundry men were counting on impregnators to seal the blocks satisfactorily. Hard-spotting, however, is a problem that threatens to wipe out two of the big economic advantages of aluminum—fast, easy machinability and long tool life. The development of hard spots, or points where the metal inexplicably is tougher than it should be, causes tools to slow down, jam, and even break.

Metal experts report you can solve the problems of porosity and hard-spotting by pouring more slowly, but this sends production rates plummeting and jacks up cost above practical limits.

Aluminum men, inclined to belittle current difficulties, say confidently that aluminum blocks will be used across the board within five years.

FALCON-ENGINE PUMPKIN SEED HITS 205.949 WITH AUTOLITE SPARK PLUGS

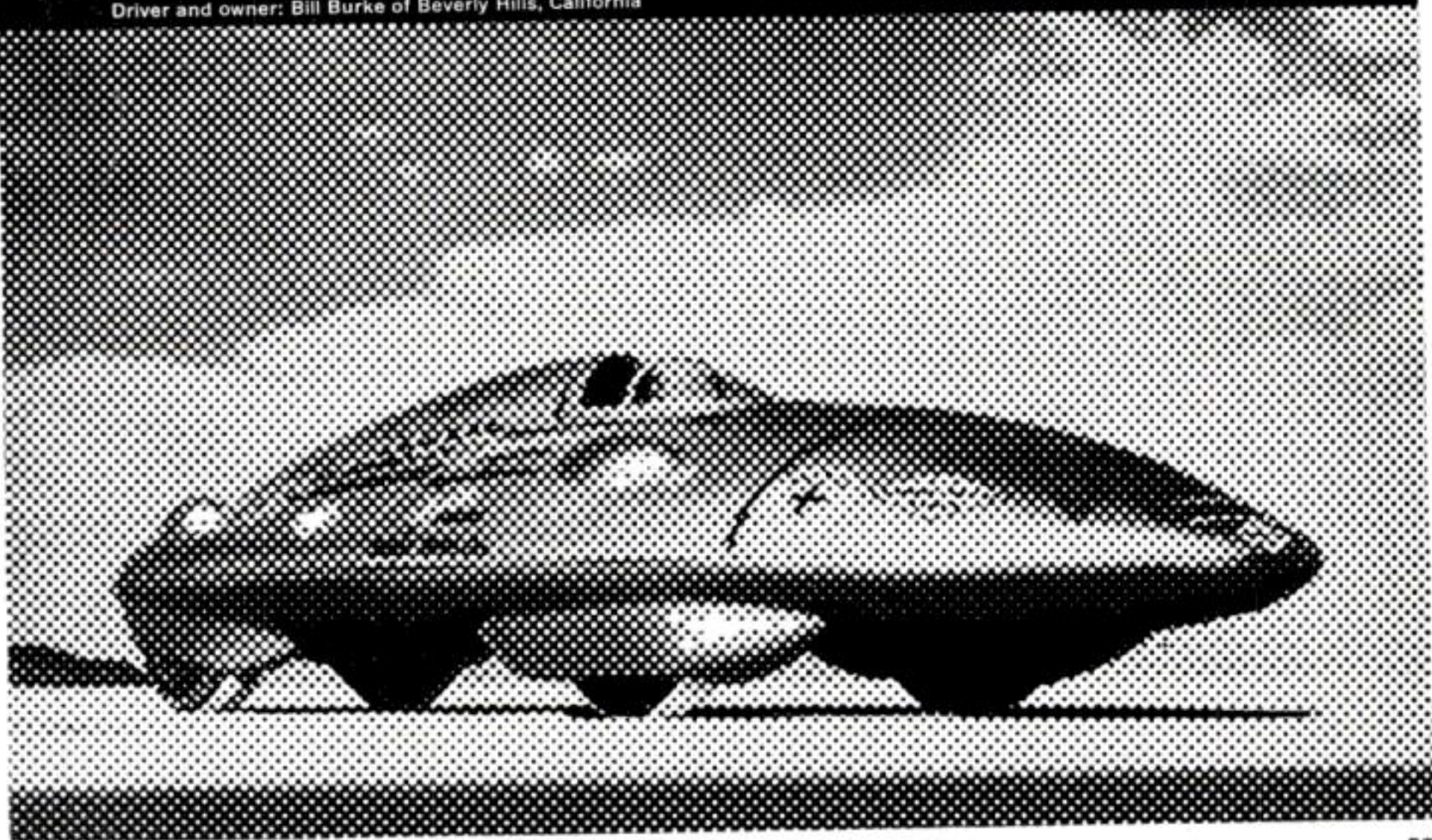
Pumpkin-seed-shaped SCI Special slices to Class D record of 205.949 miles per hour across the salt of Bonneville, smashing the ten-year-old mark by over 43 mph. The engine: a 156-cube Ford Falcon in-line six. The spark plugs: Autolite. Lesson for the day?



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Makes no difference whether your car looks like a pumpkin seed or comes equipped with a Falcon engine, Autolite Spark Plugs can't be beat. There's a set made especially for the car you drive. As the pumpkin seed proves, you're always right with Autolite.

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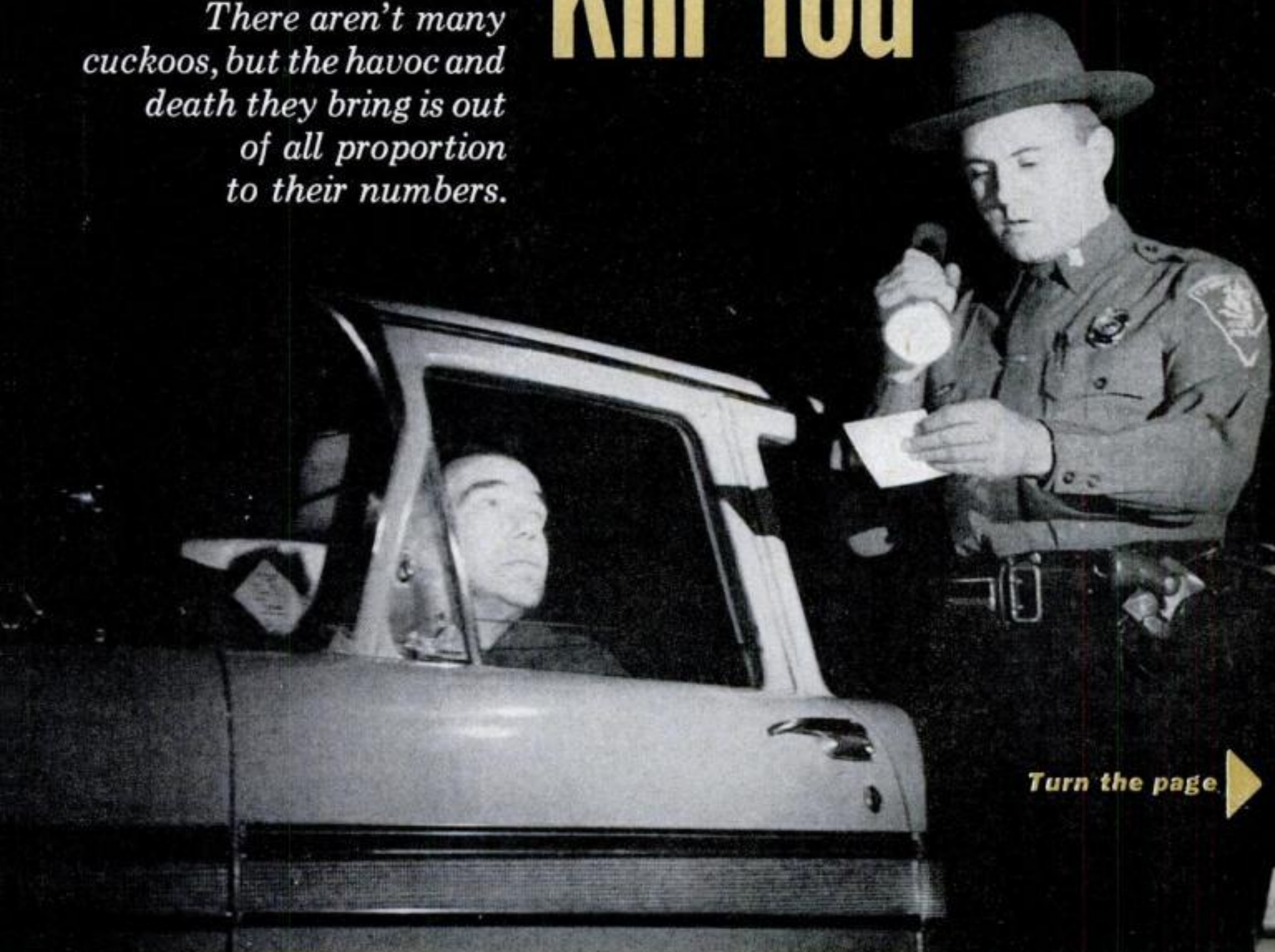
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cigarettes
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Luckies still do**

**Change to Luckies and get
some taste for a change**

Product of *The American Tobacco Company* — "Tobacco is our middle name"

In Connecticut the troopers call them cuckoos. Sometimes they're sober, but usually they're drunk—dead drunk. These are the ones who swerve through city streets at 85 m.p.h., who roar down crowded highways at 100 or faster. They're the ones who charge up the wrong side of a divided road at two in the morning. You may see their lights only once in your life. But then it's all over—you never had a chance. There aren't many cuckoos, but the havoc and death they bring is out of all proportion to their numbers.

Catching Drunk Drivers Before They Kill You



Turn the page 

Like a cavalry troop scouting Indians, a unique "satellite patrol" wheels through Connecticut to nail killer-drivers

By Edward D. Fales Jr.

ONE night not long ago a cuckoo loaded four friends into his car near Madison, Conn. He screeched out into the westbound lane of the 60-mile-an-hour Connecticut Turnpike. The trouble was, he was going east. When he hit the truck—head-on—five died.

Another one picked up a salesman, and got to bragging that his car could hit 110. Over the salesman's protests he tried to prove it. On a busy pike it was sheer madness. This one's victims were two folks returning from PTA.

Not all cuckoos are men. One grim night a woman, after too many drinks, drove east on the wrong side. A young couple, with their baby, never knew what hit them. The baby lived, an orphan.

To deal with such killer-drivers, Connecticut has launched a remarkable new kind of patrol. Six uniformed troopers in "satellite" cars are sent out to circulate around a seventh car. The driver of this car is the "eye" of the patrol and its leader. He drives an unmarked car and wears no uniform—which means that he sees a lot more than a uniformed officer in a regular cruiser would.

To avoid confusing drivers, he doesn't make arrests. His orders are: (1) Spot the bad ones and follow them; (2) vector

one or two satellite cars to them by radio; and (3) see that the potential killers are grabbed before they can kill.

I WENT to Westport, Conn., recently to ride with a satellite patrol and see how it works. We went out cuckoo-hunting. We didn't have long to wait.

We began on the Connecticut Turnpike, a modern divided highway. In this area, 12 of the last 17 deaths had been caused by drinking drivers—not mildly tipsy guys who had some rein on their senses, but drunks so far gone they leaped the center strip and hit cars going the other way.

I was watching the smooth flow of Sunday-night traffic when Trooper Donald Waite said, "Tighten your seat belt. Fast one coming."

We'd parked by the eastbound lane of the big pike in TS18, a tan Ford. This was the key car. Waite wore a blue sports jacket and no hat. Our six satellite cars had moved out from Westport with us, and were deploying around us in different directions—but never more than 10 miles, or 7 minutes, away. We were the center of a hard-hitting, mobile task force.

We didn't know exactly where they were, though we had a general idea. We knew, for instance, that TS13, with



RENDEZVOUS IN A SAND PIT: Rovers without a permanent home base, men of the satellite patrol meet anywhere — back roads, bridges, village offices — for briefing on operational plan. Their missions vary, too. Among the recent assignments: Look for pay-night drunks rolling home from late spots, set up check points to screen drivers of all cars, patrol dangerously winding two-lane roads.



THIS IS TS WEST, one of two satellite patrols led by Sgt. Ernie Harris (center). Key man is plain-clothes leader, Trooper Don Waite, who

spots and tails the killer-drivers. He radios uniformed troopers, cruising around him as satellites, to zip in and nab the "cuckoo."

Trooper Walt Trella, was somewhere up ahead. TS17, Charley Hyatt, was up there, too. TS, incidentally, stands for "Traffic Squad."

OUR first cuckoo went by like the wind—fast. Our car, TS18, looked like any other '59 Ford, but under the hood was a 430-cubic-inch (350-hp.) job called a "Thunderbird Interceptor." We went out like an arrow from a bow.

In the first dash—to get his number—we flew. We happened to go by a radar. The operator saw us coming and radioed: "Your speed is . . . one-zero-zero. He's eight seconds ahead." This was in a clear stretch. No cars. We got the number and slowed down.

Not so the cuckoo. He had gone by the radar at 91, still accelerating. At what must have been 110 he zigzagged through a pack of 10 cars traveling at the legal

60. It was bloodcurdling. A few more passes like that and there would be iron and people all over the turnpike.

Waite punched a radio switch. This cut off the regular headquarters channel and swung us over to the emergency 29.23-megacycle car-to-car channel, life-line of a satellite patrol.

"TS18," Waite called, "to all TS cars. We are eastbound behind blue '56 Olds, terrific speed. Grab this guy quick before he kills some people."

For a moment, silence. Then things happened fast. TS17 checked in first. He was five miles east and coming toward us, but would turn and try to intercept the Olds. TS14, Jim Jacob, was two miles behind and coming up fast. One or two others were on nearby roads and immediately turned around and sped toward the pike.

We kept them posted. "He's about 20



"FORD AHEAD MOVING FAST EASTBOUND," radios leader Donald Waite over direct car-to-car channel. Knowing where satellite cruisers are, he can order nearest one in to make arrest.



PLUG-IN DASHBOARD BEACON identifies unmarked cruiser as police car—but not until Trooper James Jacob wants it known. When he stops, beacon is moved to roof (note long cord).

CONTINUED

61

The driver fell over flat. He giggled, "It's a good thing

cars ahead of us . . . Moving from first to third lane . . . Just passing a big tanker."

Then a crisp voice cut in, loud and close. "I'm two miles ahead and waiting . . . I think I see him coming." It was big, good-natured Walt Trella in TS13. Silence again. Then Trella cut in. "I'm right behind him, Don. Man, is he a flyer."

Then Trella had him. TS17 and TS14 roared up to help. In three minutes they'd neatly lifted a death maker out of all that Sunday-night family traffic. His tires were paper-thin, and too hot to touch.

"These fellows lose control and everything explodes," Waite commented. They hustled the man off to a police station. We went back to looking for more cuckoos.

BY SUCH lightning tactics Connecticut is chopping down the killers. On roads around Danbury, highway killings for six months dropped from 28 to 14 when a satellite patrol moved in under a quick-thinking sergeant named Ernie Harris. (Such a saving, if maintained over a 10-year period, would total an incredible 280 lives saved in this area alone.)

Connecticut at present is running two satellite patrols, "TS East" and "TS West," and soon may have more. I rode

for a day and nine nights with TS West and saw them pluck a number of cuckoos out of traffic. Some were fighting drunk. One, skillfully fished out of the wrong turnpike lane before he hit anybody, said thickly: "I feel sorry for all those guys going the wrong way."

Each day we were posted on where the patrol would meet that night. For the satellites are rovers; they have no base of their own. The key car is a flagship that sets the strategy. Sometimes we met on lonely roads, once under a bridge in a rainstorm, sometimes in sand pits, and twice in a back room of a town hall.

There Trooper Don Waite or Sergeant Ernie Harris would brief us. One night, for example, we were to look for three-a.m. "pay-night drunks" rolling home from late spots. Another night we were to set up a surprise "check point" and screen all cars passing—especially toward midnight—for cuckoos.

After the briefing we'd roll out quietly. All our cars had those big Interceptor engines. And the plain car had a disappearing red flasher, clamped on top of the dash panel, that could be lowered to the floor to avoid drawing attention. Each car had three-way radio. (Whenever we transmitted we'd hear the dynamotor whirring under the rear deck.) Each car carried a kit for testing any driver arrested as a "DD" (police jargon for drunk driver).

THESE patrols are the work of an able, two-fisted lawman, Leo J. Mulcahy. Eighteen months ago Mulcahy, an up-through-the-ranks trooper, was picked by Abraham Ribicoff, then the state's safety-minded governor, to be his police commissioner. Mulcahy came to the job with a mission already planned.

For years as a trooper he'd been sickened by the highway deaths he'd seen. Many experts tell you that deaths are caused by decent people who make one fatal mistake. Some are. But Mulcahy knew that more than half the slaughter was being caused by hardened violators, criminals, and drunks. He knew, too, that many a driver reported as "going to sleep" at the wheel had actually passed out, but that newspapers don't dare say so unless there's a charge of intoxication.



NIGHT-SPOT SURVEILLANCE is steady assignment for the satellite patrol. Topsy revelers who insist on trying to drive themselves home are arrested before they can cause any harm.

I'm not drunk." Nobody laughed.

CHILLING EXAMPLE—a horribly mangled Merc displayed on police trailer—is examined by Connecticut's State Police Commissioner Leo J. Mulcahy (center). An up-from-the-ranks trooper, Mulcahy organized the satellite patrols the day he took office (and had them in action that afternoon). Mulcahy blames most auto deaths on hardened violators, aims to get them off the road before they kill.



Mulcahy had also learned that hardened violators and nuts are often able to smell a uniform a mile away—and to go on good behavior. Hence his choice of a plain-clothes “eye” for each squad. Not one to fool around, Mulcahy set the squads up on his first day in office: July 1, 1959. At two p.m. they rolled out.

Within days the toll began to drop as word got around. Newton, Conn., which had had six recent deaths, sent an S.O.S. to the new patrols. TS West ghosted in. One of the first to learn about it was a local wild one. This fellow had learned that by sheer insanity he could outrun a cop. He tried it once too often. He went through Danbury's main street at 86 m.p.h. This time the air around him crackled with radio calls. Suddenly the TS men were everywhere—and he was in the net.

IT WAS on my ninth night with TS West that we met the bad one.

The night had begun with two or three small chases. Route 6 near Danbury is a narrow two-lane roller-coaster, a dangerous road. A red convertible came up fast behind us, passing cars willy-nilly on blind hills. He made his mistake when he gave us the business, too, and then narrowly missed a head-on crash on the hilltop ahead.

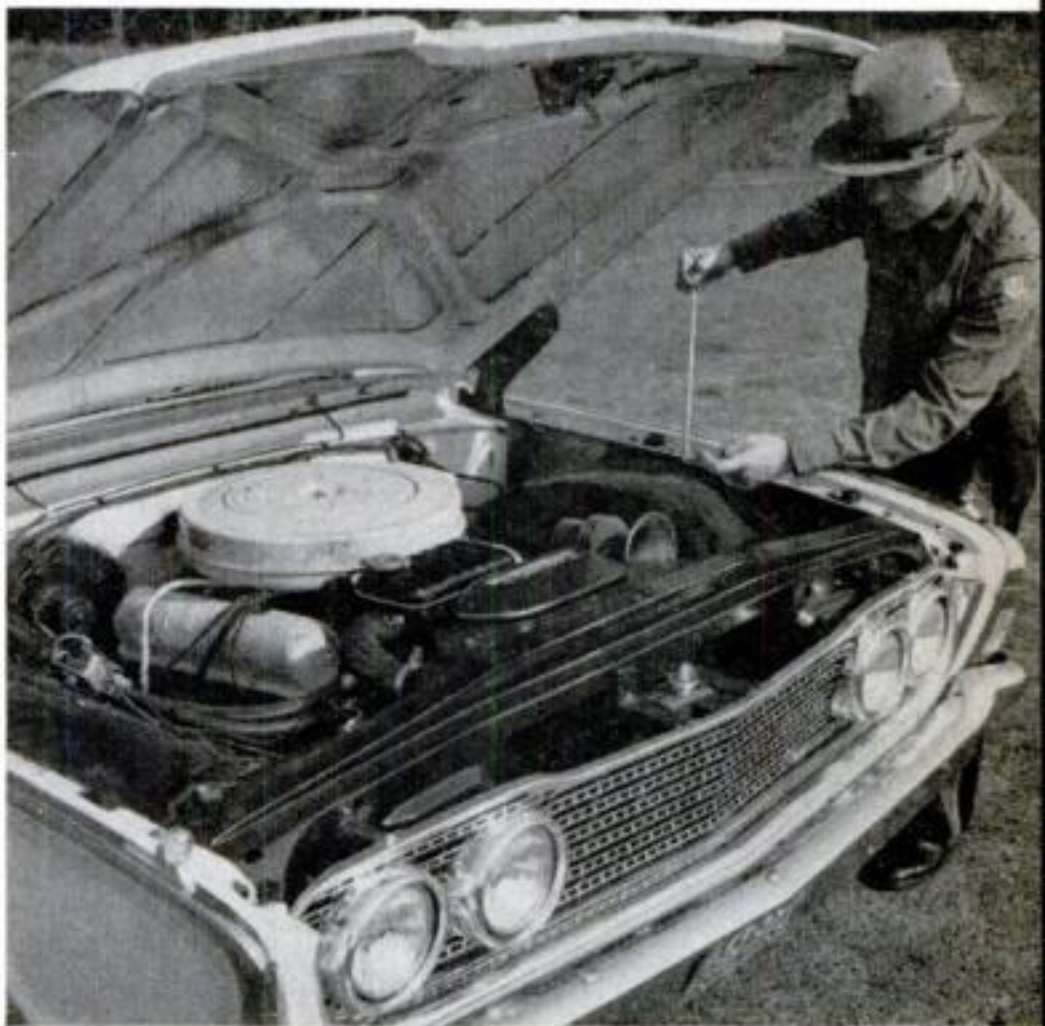
We roused two TS cars. He was startled when red lights began to blink all around him.

“What are you stopping me for? I didn't do anything,” he protested.

They told him that Trooper Waite had been in one of the cars he had careered past. He was arrested.

WE WENT on. Soon we were on a road where not long ago two women, driving home late one night, had met a

[Continued on page 224]



JUST '59 FORDS ON THE OUTSIDE, unmarked patrol cruisers hide hopped-up mills under their hoods. The special police Interceptor engine gets 350 hp. out of its 430 cubic inches.



STEERING PANEL, instead of wheel, with Ray Besasie Sr. driving, guides car. He sits in the center, steers by swaying his knees. Hand knobs

at corners give assist, if needed. Horn button is between them, shift stick up front. Toggle switches control the Explorer's lights.

Knee pressure steers this car

No-hands driving is simple with this car. It steers, in traffic or on the open highway, by pressure of the knees on a panel under the dash. The driver sits in the center where he can judge distances on both sides. The ultramodern Explorer was designed by Joseph Besasie of Mil-

waukee, Wis., an associate of designer Brooks Stevens. It was built by his father and brother, Ray Sr. and Jr.—their third car in four years.

The Explorer has a modified Cadillac engine with 4-inch bore and $3\frac{5}{8}$ -inch stroke, 368-cu.-in. displacement, $10\frac{1}{2}$:1

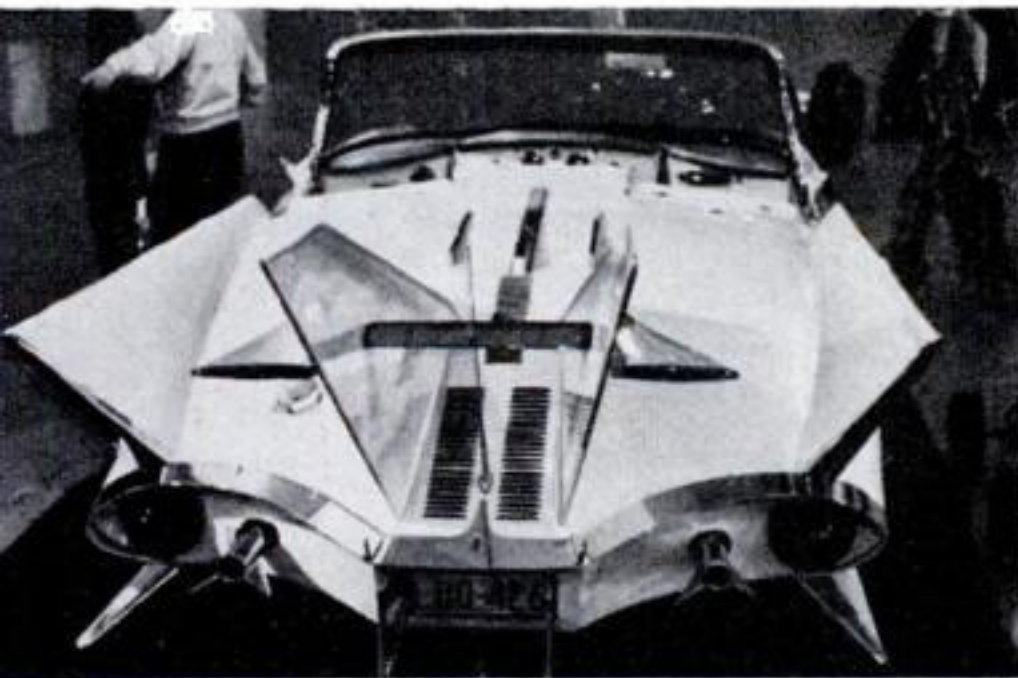


Space possum

The saddlebag this opossum is wearing was tailored specially for him in the leather hobby shop at Kelly Air Force Base, Tex. It carries instruments to measure the animal's brain waves and heartbeat during a space experiment being conducted by the Brooks Base Aerospace Medical Center.



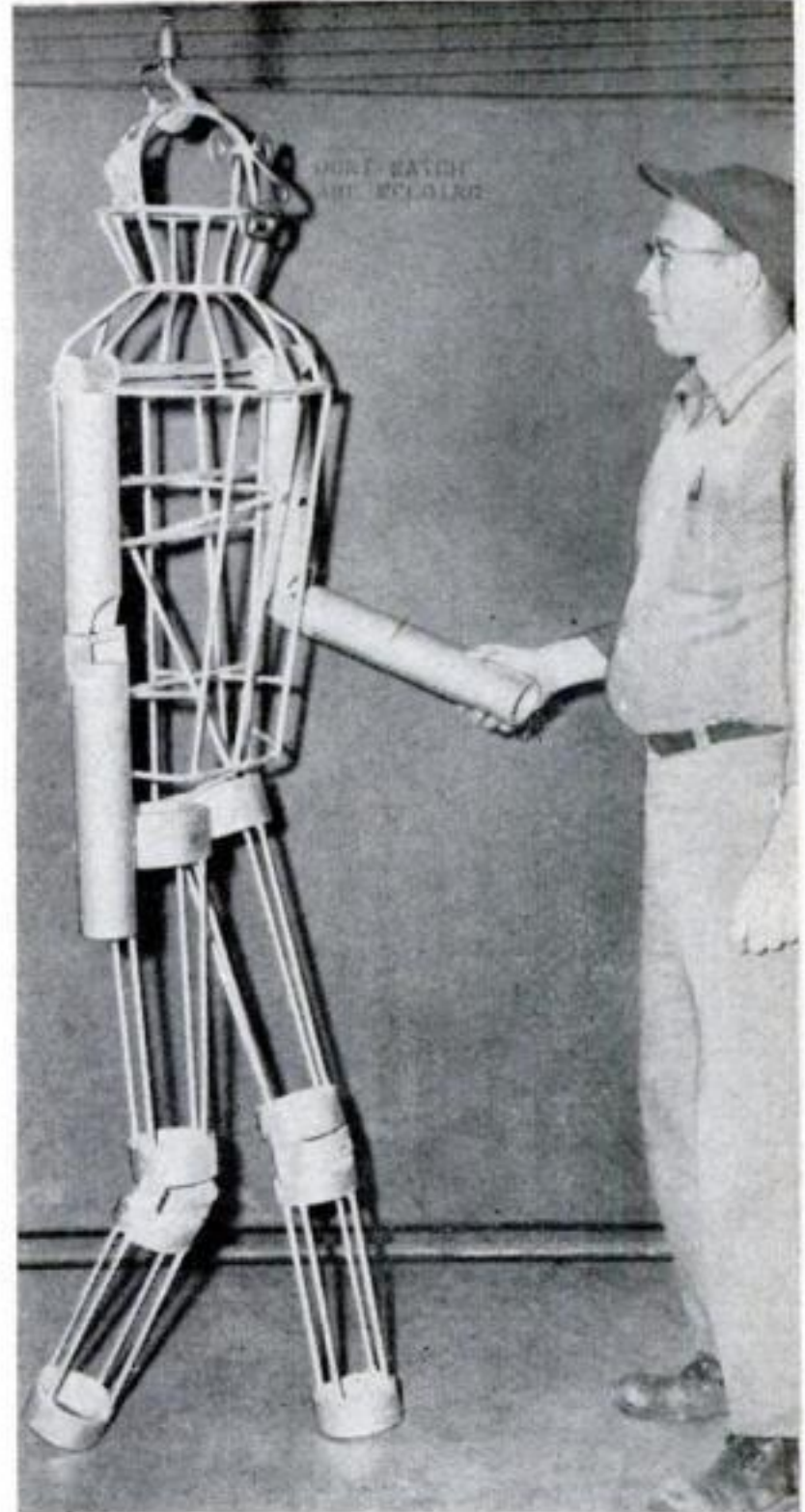
HANDMADE BODY is formed of aluminum. Indented step plates on both sides are for climbing in and out, eliminate need for doors.



REAR VIEW of Explorer reveals extra, central fins. Grille between them is ornamental; the eight-cylinder engine is up front under hood.

compression ratio. It develops 350 hp., gets 21 miles to the gallon. Top speed is 140 m.p.h. It's 19 feet, 4 inches long, and 72 inches wide.

The Besasies sold their first two cars after nationwide tours; this one was sold before it was even built. Price: \$20,000—\$15,000 for 3,000 man-hours' work, \$5,000 for engine and materials.



Bird-cage dummy

Wood-and-fabric dummies, used to train rescue crews in getting survivors out of crashed planes, have given way at Dover Air Force Base, Del., to this one constructed in the base welding shop. It's made of lengths of pipe and rods, is hinged at shoulders, elbows, waist, and knees to react like a man—and can better stand the flames accompanying a simulated crash.

Multiple tandem

The eight houseboats at right, rigged together in two rows of four, made a 680-mile Mississippi voyage from Dubuque, Iowa, for delivery to marinas in Missouri and Kentucky. Powered by twin Mercury 80s, they were piloted from atop the rear two boats.



Million-Gallon Teakettle Brews Fresh Water from the Sea

San Diego's big still—possible forerunner of nuclear stills—will tap the ocean for drinks

By Wesley S. Griswold

BEFORE the end of this year, San Diego will be drinking water drawn from a limitless reservoir—the sea. The draft will be a million gallons a day.

That's a drop in the bucket compared to the more than 75 million gallons that San Diego, a city of 573,224 people, already consumes in an average day. But the significance of the "drop" immensely exceeds its size.

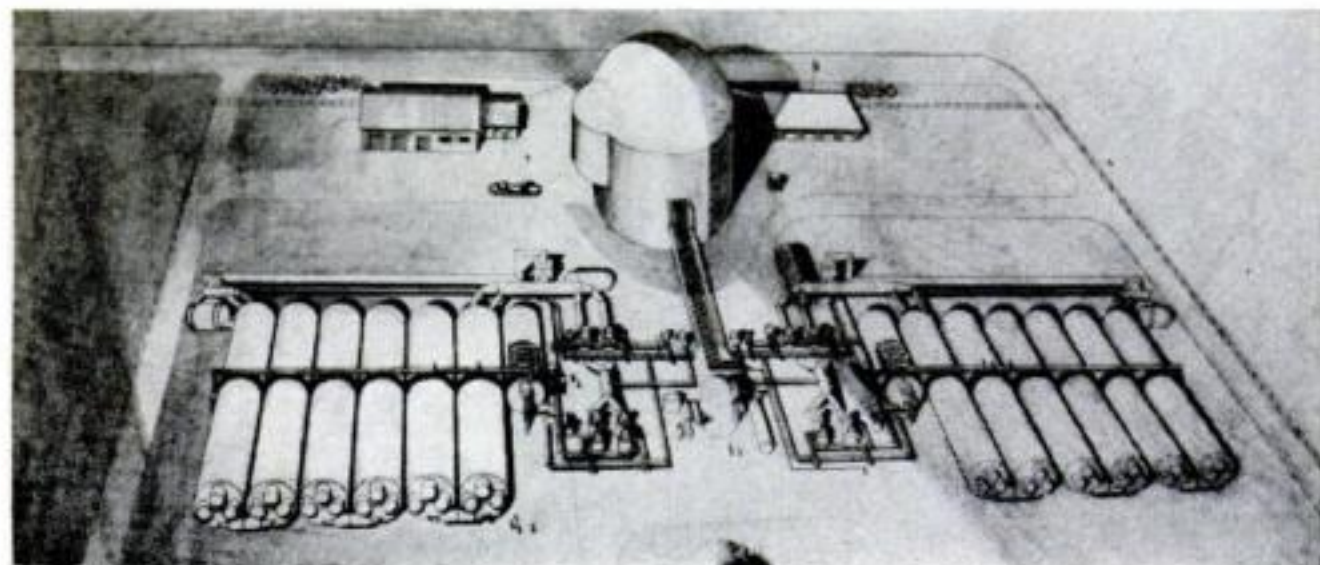
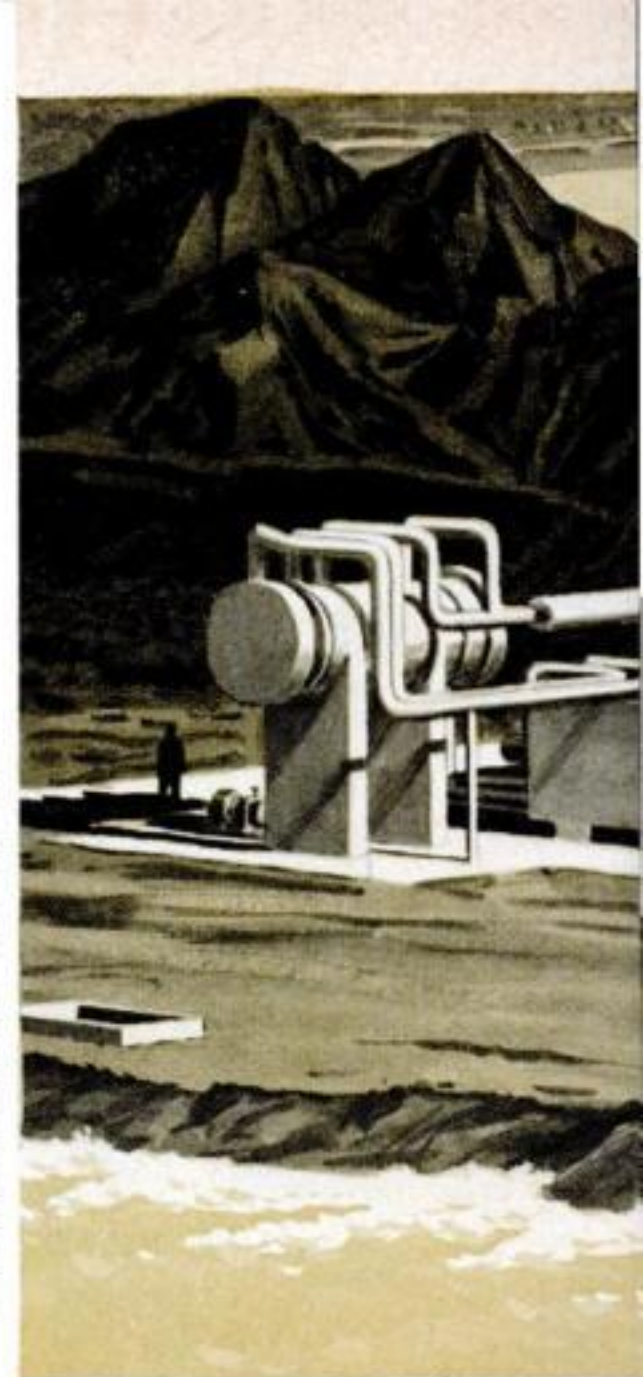
The little salt-water-conversion plant now being built on the tip of Pt. Loma, at the entrance to San Diego's famous harbor, is experimental. It may, however, lead the way to a permanent solution of one of the world's most serious problems: how to find enough water for an exploding population.

Water, water, everywhere. The problem is really not one of locating abundant water—seven-tenths of the earth is covered with it—but of making it available and drinkable at a practical price.

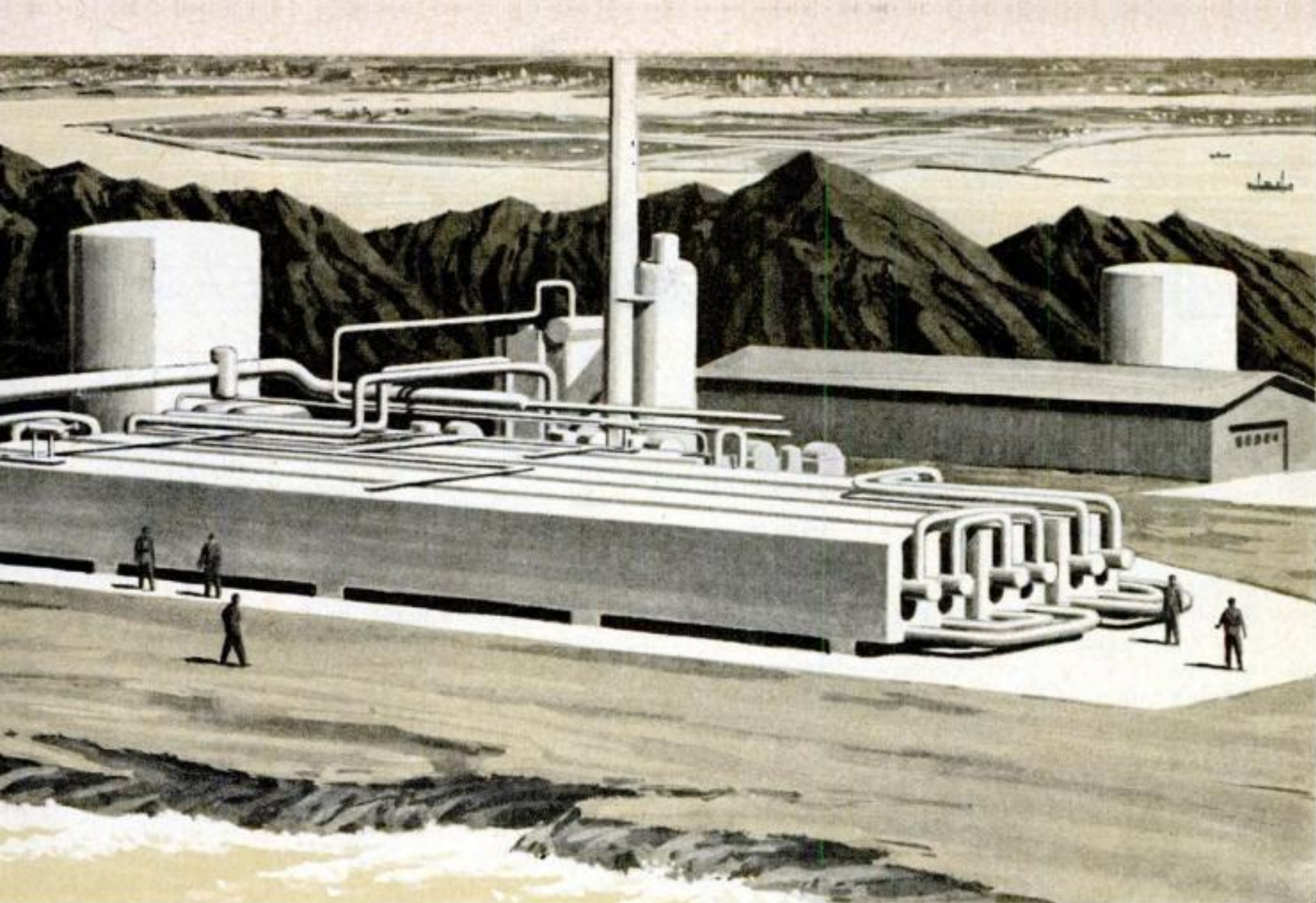
Tremendous progress has been made in

BY END OF 1961 this plant at Pt. Loma, Calif., will be turning salt water to fresh in long, low evaporator chambers (foreground). Big storage tank in left background holds purified water. Tank in background at far right is for fuel oil, burned to heat sea water on its way to be boiled in evaporators.

cutting the expense of extracting fresh water from the oceans. Only eight years ago, the product cost \$5 per 1,000 gallons. The pilot plant rising on Pt. Loma is expected to produce it for \$1 per 1,000 gallons. Looking ahead a dozen years, the engineers who designed the plant predict that a very much bigger one of the same type, using nuclear heat and pouring out 130,000,000 gallons of fresh water a day, could cut the cost of purifying the briny deep to as low as 24 cents per 1,000 gallons. They foresee a number of these nuclear-heated conversion plants eventually dotting our seacoasts. By that time, the same engineers estimate, obtaining new supplies of fresh water from the



MODEL SHOWS bigger-scale plant for same multistage flash-evaporation process as at Pt. Loma, but with heat supplied by a nuclear reactor, in domed 140-foot-high building. Installation of this size would provide 50 million gallons of fresh water a day, enough for 250,000 people.



dwindling sources we now tap will in many places be more expensive than removing the salt from sea water.

Let's look at the installation taking shape at the mouth of San Diego Harbor. Westinghouse is building it. The Fluor Corp., of Los Angeles, designed it. The U. S. Interior Department and the State of California are putting up the \$1,600,000 to pay for it. San Diego has contracted to take its entire output.

The plant is rising on a 50-acre shelf of land 36 feet above mean low tide. Its essential units—long, horizontal evaporators, pumps, oil-fired steam boiler and tall smokestack, storage tanks for fresh water and fuel, a low building for offices

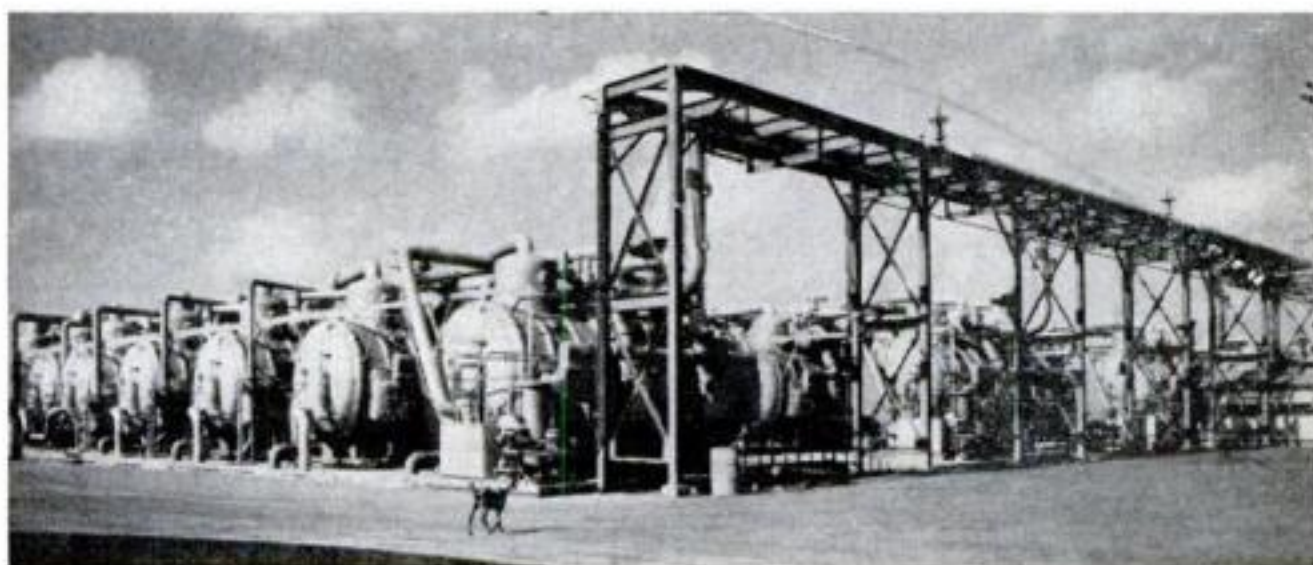
and shop—will occupy only a small portion of the site, a plot 350 by 300 feet.

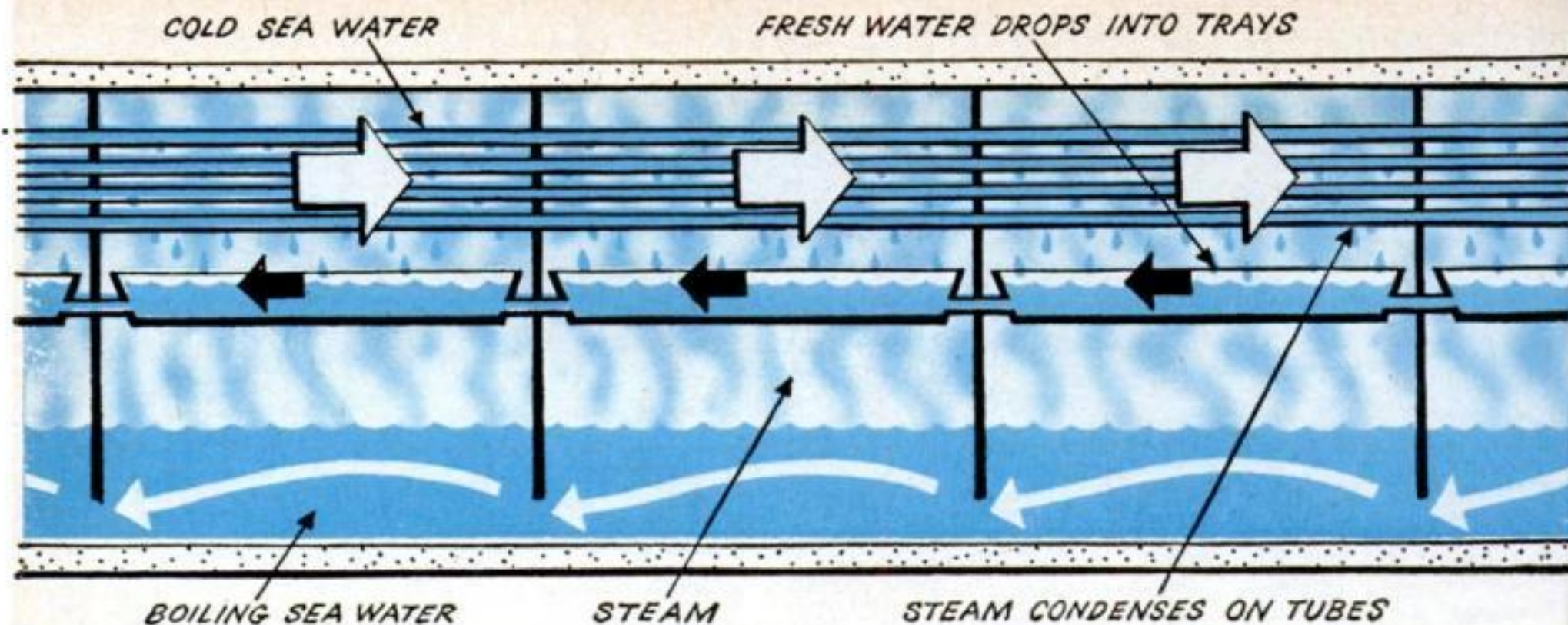
Siphoning off an ocean. Sea water will flow in by gravity, coursing down an inclined 24-inch concrete pipe whose mouth will lie 700 feet offshore and 11 feet below the level of the lowest tide. The water will be screened at the intake. At the shore end of the pipe, there will be a sump. Salt water will be pumped to the evaporators from there.

In essence, the conversion plant at Pt. Loma will be an elaborate and cunningly refined teakettle. It will boil salt water, condense the pure steam that results, and collect the fresh water for distribution.

Ironically, the end product will be so

BIGGEST IN WORLD in operation so far, this sea - water - conversion plant supplies needs of 55,000 people on island of Aruba, near Venezuela. It produces 2,700,000 gallons of fresh water daily by same multiple-effect distillation process U.S. will try out at Freeport, Tex.





HOW SAN DIEGO PLANT DESALTS WATER is shown in cross sections of evaporators, above and opposite, and in simplified flow chart on rest of facing page. At subatmospheric pressure

in evaporator, hot sea water flashes into vapor. Fresh water condenses on cold pipes and drips into collecting trough. This repeats itself in 36 chambers at successively lower pressures.

pure that it won't taste good until a few ingredients have been put back in it. Until mixed with air and a judicious assortment of chlorides, sulfates, and carbonates, it will be tasteless.

The process used in this conversion plant is called multistage flash evaporation. Another, and less efficient, version of it is daily making 2½ million gallons of drinking water for the people of Kuwait—the tiny kingdom that bakes beside the extremely salty Persian Gulf.

The process involves sending sea water on a short round trip through a series of evaporators. Each evaporator contains a number of vacuum chambers, separated by vertical baffles. These compartments are the "stages" of the process. There will be 36 of them in the installation at San Diego. Temperature and pressure vary by precise degrees from stage to stage.

No bubbles allowed. As the incoming sea water starts its journey through the system, a de-aerator first takes all the air out of it. That is done so that escaping air bubbles will not hinder maintenance of a partial vacuum, later in the process; and also to prevent oxidation of the metal en route. The water is then treated with chemicals to inhibit the formation of scale when it's heated.

On the first leg of the trip, the sea water travels in a bundle of tubes running along the ceiling of each evaporator. As it passes through one chamber after another, the water in the tubes is gradually

heated. It remains under constant pressure to prevent it from boiling, until that becomes desirable.

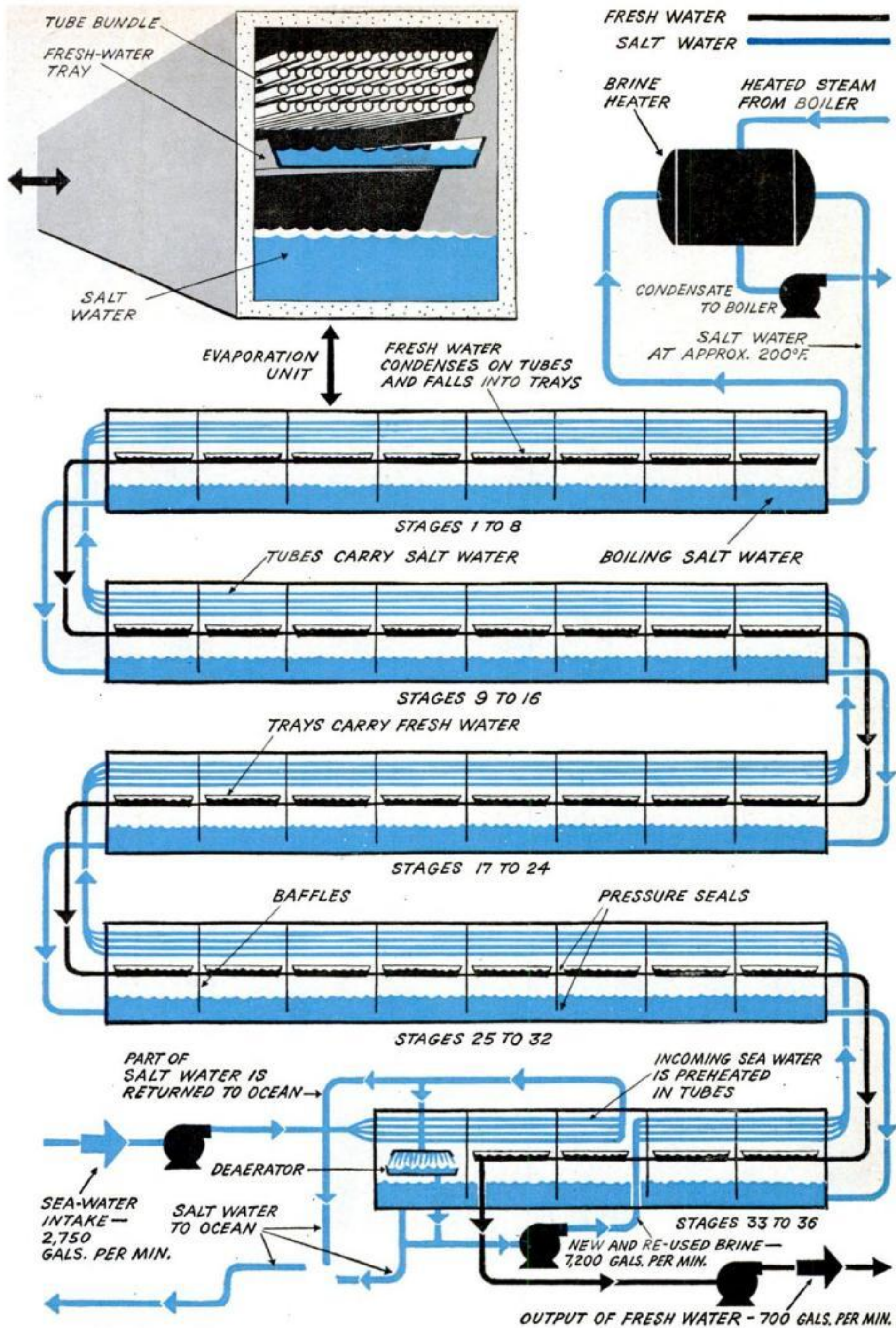
At midpoint of its journey, the saline water circulates through tubes in a steam heater. There its temperature is raised to about 220 degrees F. It then starts back the way it came. But now it is no longer in pipes; it has become a river of hot brine flowing along the bottom of each evaporator.

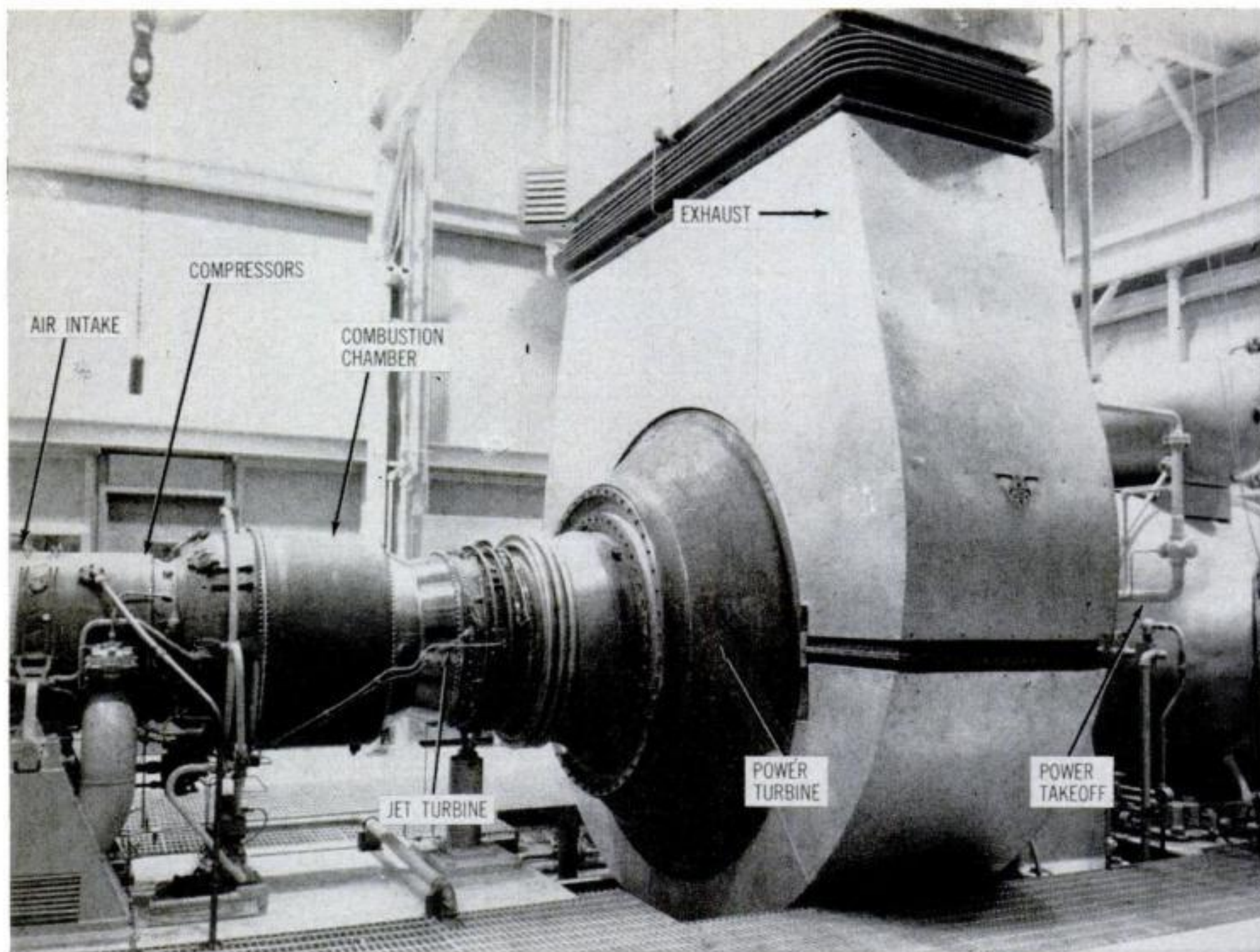
Here, halfway through the system, is where flash evaporation begins. As the brine enters the first stage of its return trip, it encounters slightly reduced pressure. Instantly, a part of it boils (flashes). Steam rises and condenses on the tubes carrying incoming sea water toward the heater. The water in the tubes absorbs the heat of the steam. The pure condensate formed on the outside of the tubes drips into a trough lying beneath them.

Then, brine and condensate flow into the adjoining chamber, where pressure is lower. Here again the brine boils and gives off steam. More pure water forms on the tubes and drips into the trough.

This process is repeated, through stage after stage, until the return journey is over. In the final chamber, water fresh from the sea, with a natural temperature (at San Diego) of around 65 degrees, is just entering the overhead pipes. The brine, heated to 220 degrees when it left its steam bath, by now has cooled to

[Continued on page 230]



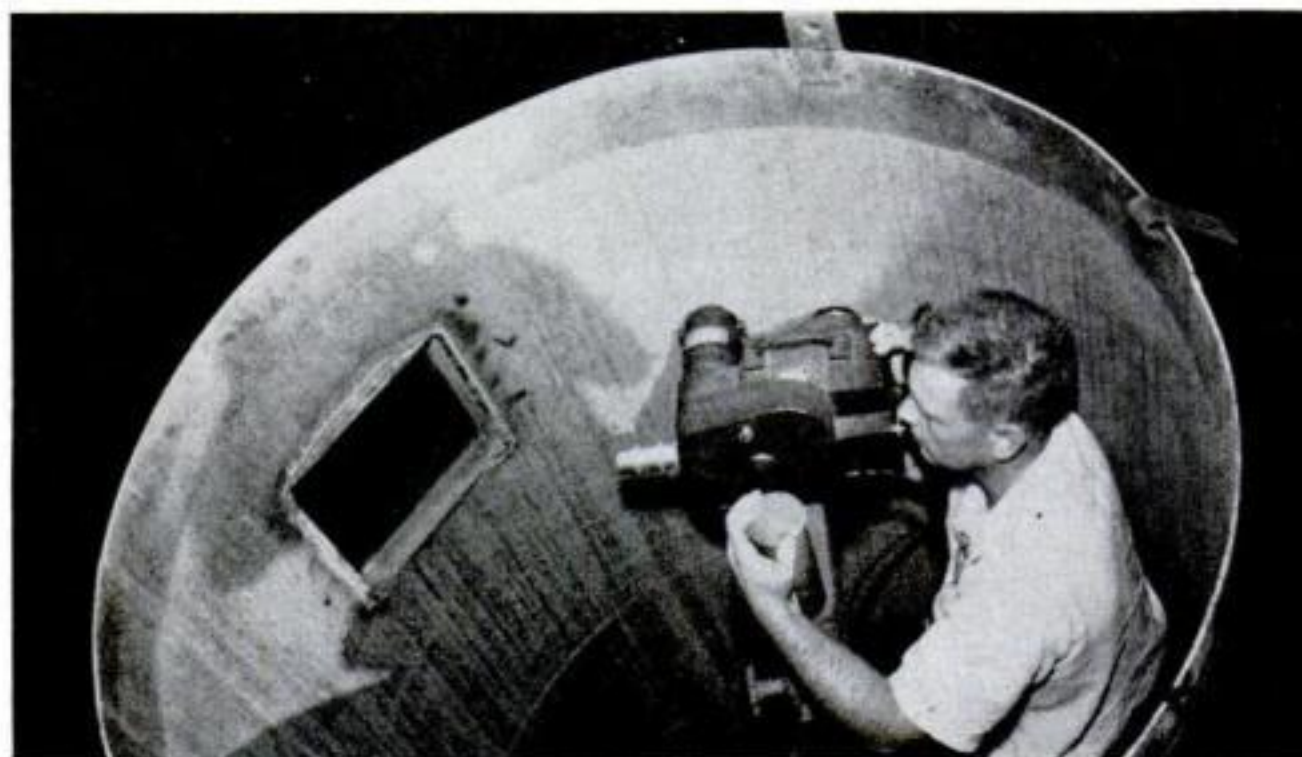


Aircraft jet does down-to-earth job

An aircraft turbojet spins a free turbine above—the first industrial use of an airplane jet. No shaft connects the two; blast from the jet spins the turbine, which boosts flow of natural gas on its way to the East. The jet is powered by some of the gas it helps pump. The installation is in a pumping station at

Possum Trot, Ky., being tested by Pratt & Whitney, Cooper-Bessemer, and Columbia Gulf Transmission.

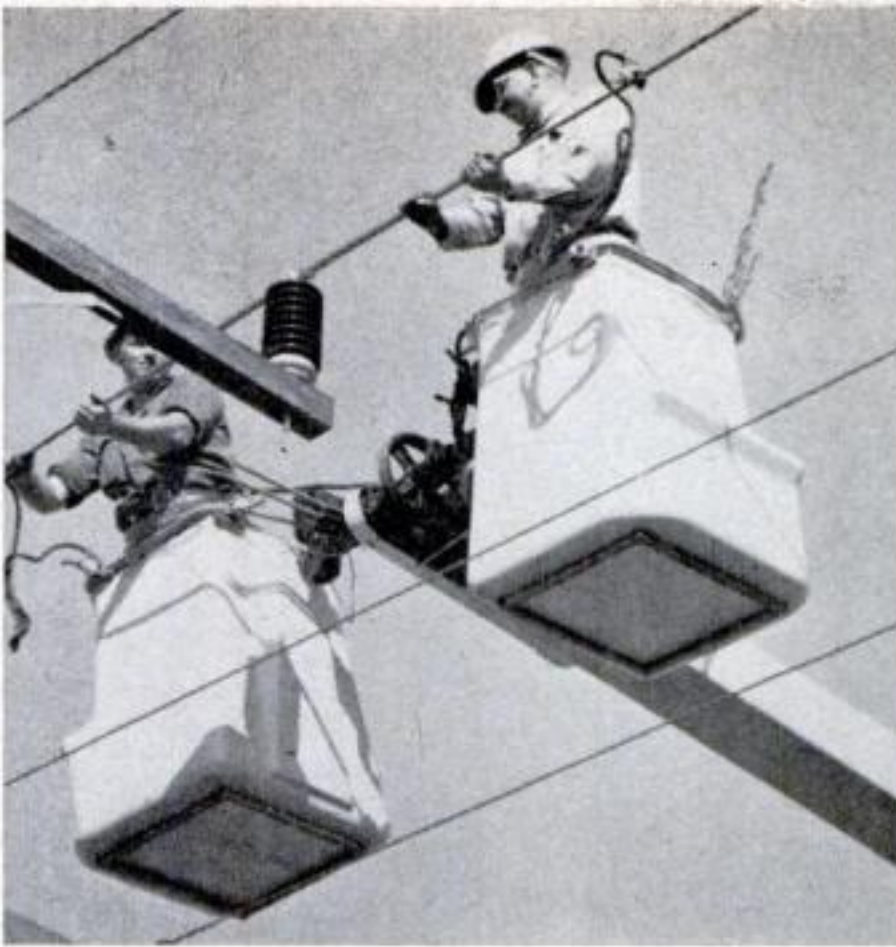
Advantages so far over conventional turbines: lighter weight, cheaper installation, lower fuel and operating costs, no regeneration system needed, no attention required for at least a year.



Underwater photography

Crouching below water level in a protective tank, this photographer uses a high-speed camera to take pictures of uranium-fuel elements.

It's part of a GE study to show engineers how waste elements will behave when discharged from a new atomic reactor being built at Hanford, Wash.



WHAT, NO GLOVES? These linemen work in safety with bare hands on a high-voltage wire.



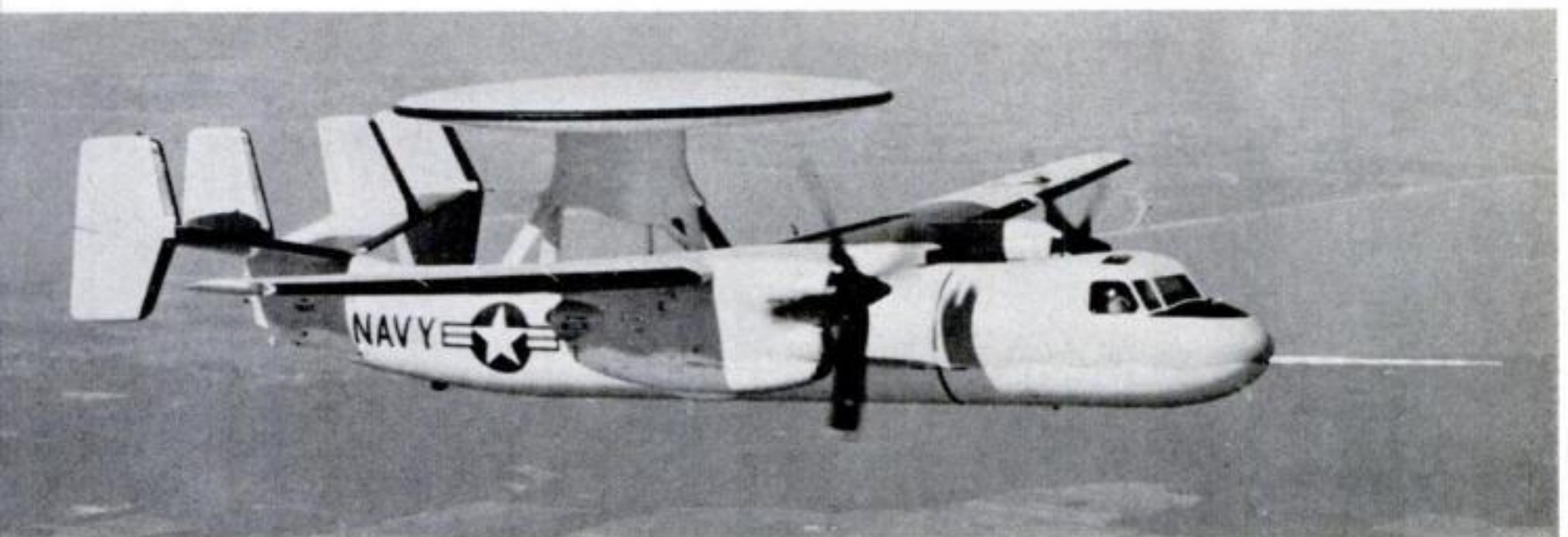
BOOM ON TRUCK is insulated so current from live wire can't pass through it to the ground.

No fear of shock

Working barehanded on a live wire, these two American Electric Power linemen repair a 34,500-volt line near Findlay, Ohio. They stand in nonconducting fiber-glass buckets supported by an insulated boom on a rubber-tired truck. The

metal lining of the buckets is connected to the live wire, charging the men with the same voltage. But no current passes through them since they are as electrically isolated as a bird sitting on a wire.

The idea is new in power-line maintenance. It's safer, less cumbersome than using the familiar insulated hotstick.



Airborne radome protects Navy ships

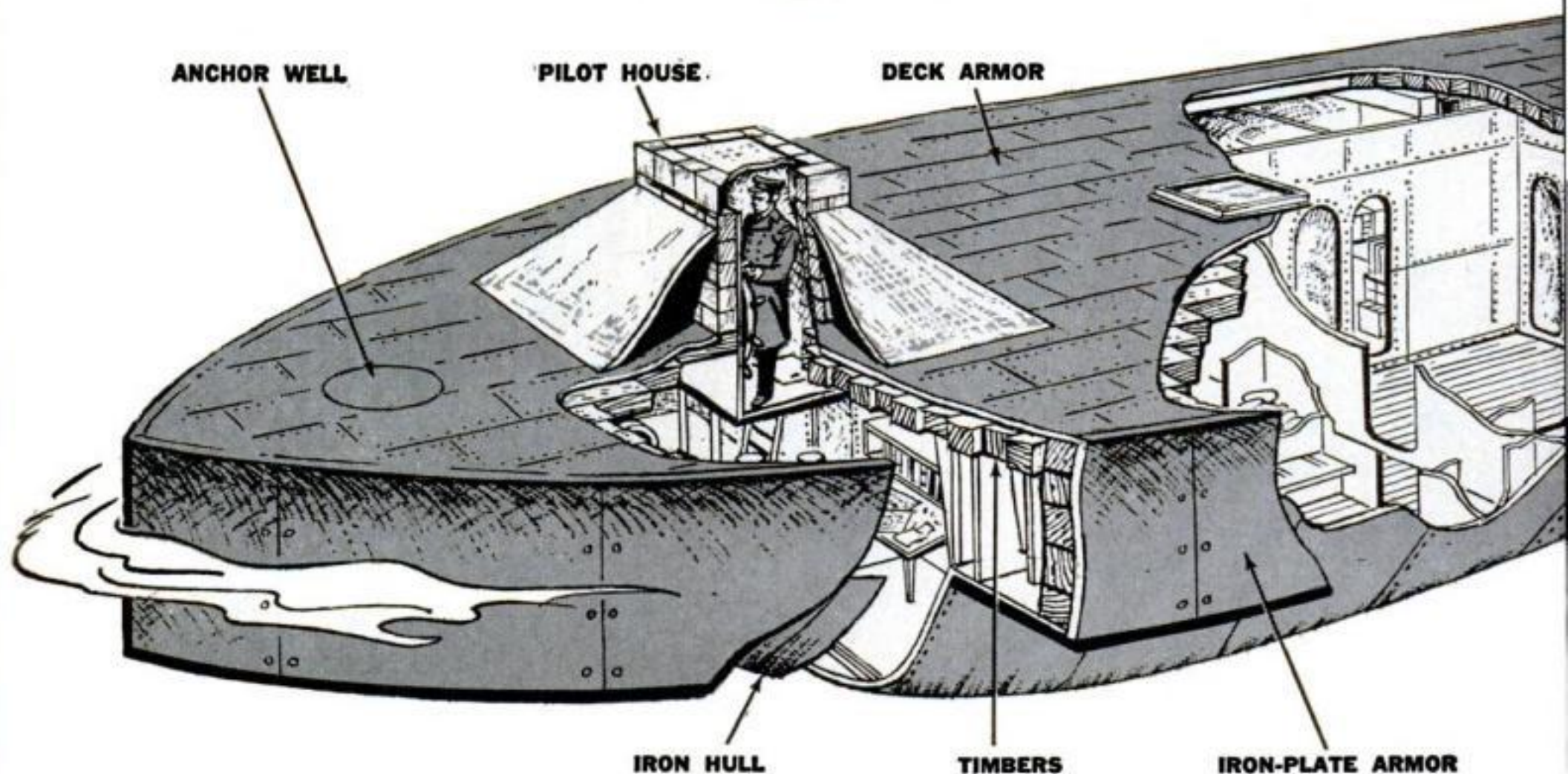
A structure that looks like an oversize bridge table now rides on top of a special kind of carrier-based Navy plane. It's a radome, designed to alert Navy task forces to the presence of enemy planes hundreds of miles away.

The special aircraft are Grumman Hawkeyes propelled by two turboprop engines. The surveillance radar in the flattish dome is combined with a computer "brain" in the airplane that sup-

plies instantaneous information to fighter planes waiting to intercept intruders.

The radome stands six feet above the plane's fuselage. To make storing the planes in below-deck hangars possible, hydraulic motors lower the radome 22 inches. The W2F-1 Hawkeye is a sister plane to the Navy's Super Constellation WV-2E radar picket plane used as an airborne extension of the DEW Line—our arctic early-warning system.

The MONITOR: History's Strangest Warship



A hundred years ago, they laid the keel of the Monitor—the iron ship that would sound the death knell of wooden navies

By Harry Walton

A NAVAL crisis early in the Civil War was met by an engineer, a 100-day shipbuilding miracle, and a vessel like none the world had ever seen—the Monitor.

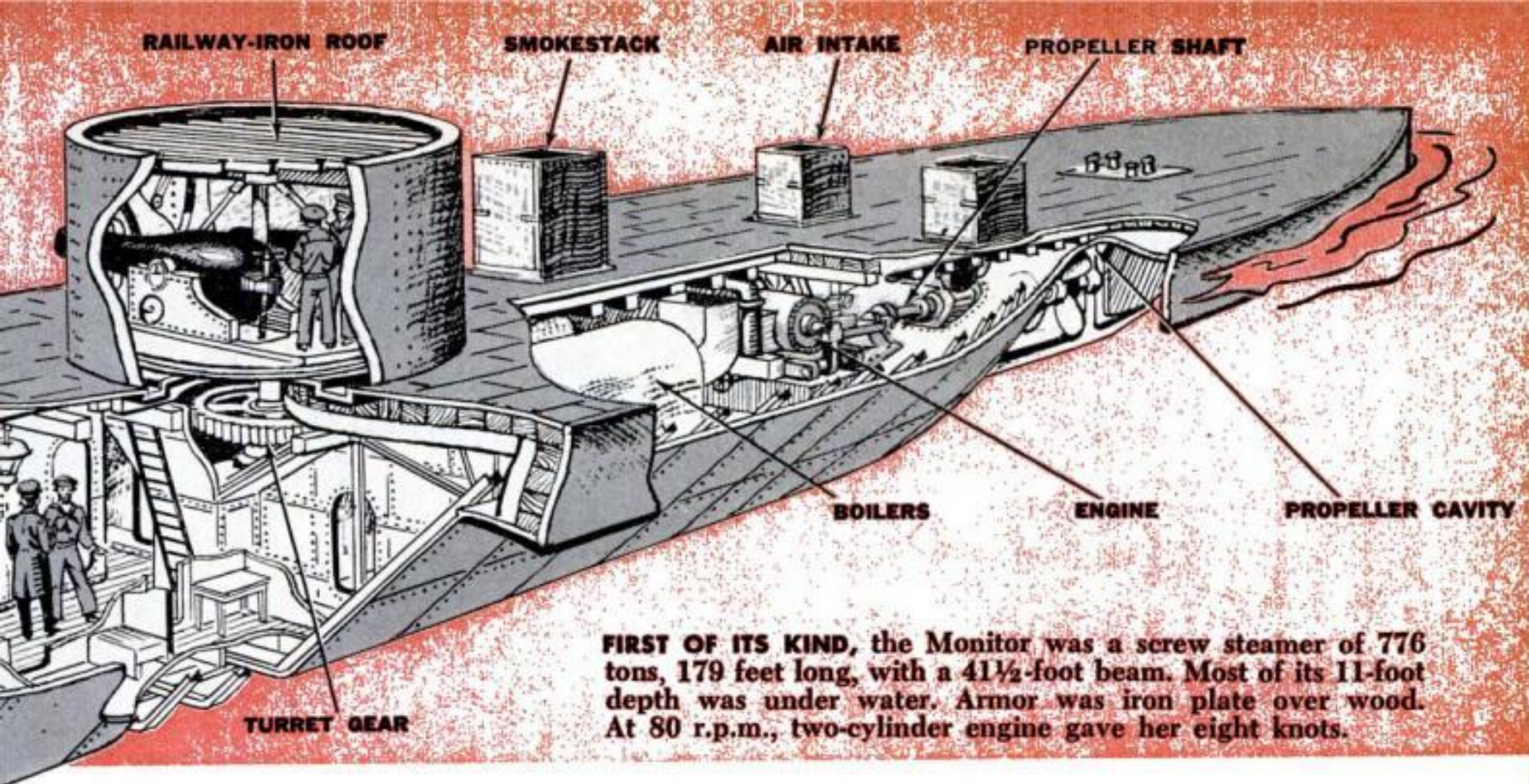
The impetus to build this iron freak was a fear that the Confederates might break the Union blockade with ironclads. Unable to match the North ship for ship, the Confederates counted on armored ones to even the odds. One such was the captured U. S. frigate Merrimac, rebuilt with a casement of wood and iron plate, fitted with a formidable ram, and renamed the C.S.S. Virginia.

So high were Southern hopes for her that Stephen Mallory, Secretary of the Confederate Navy, proposed sending the vessel to shell and burn New York and its shipping. "The Brooklyn Navy Yard and all the lower part of the city could be destroyed . . . Peace would inevitably

follow," he wrote. This was wild optimism. Actually, when afloat, the ship's armor sank her to a draft of 22 feet and made her unable to navigate in heavy seas or carry coal for more than a few days. Her defective engines could lug her along at no more than five knots. But apprehension ran high, for ironclads were new and fearsome things.

The Union navy had been reluctant to adopt them, even though England and France had such ships. But to John Ericsson, a Swedish engineer who spent most of his fruitful life in this country, ironclads were no novelty. Napoleon III had used them in the Crimean War. In 1846 Ericsson himself, having developed powerful guns, said that enough armor to withstand them would sink a ship—and then countered by drawing plans for a revolutionary new kind of vessel. These, dusted off in 1861, became the Monitor.

It embraced several of Ericsson's firsts—engines wholly below deck, fires sup-



FIRST OF ITS KIND, the Monitor was a screw steamer of 776 tons, 179 feet long, with a 41½-foot beam. Most of its 11-foot depth was under water. Armor was iron plate over wood. At 80 r.p.m., two-cylinder engine gave her eight knots.

plied with air by blowers, a movable gun turret, recoil carriages, direct coupling between engine and screw.

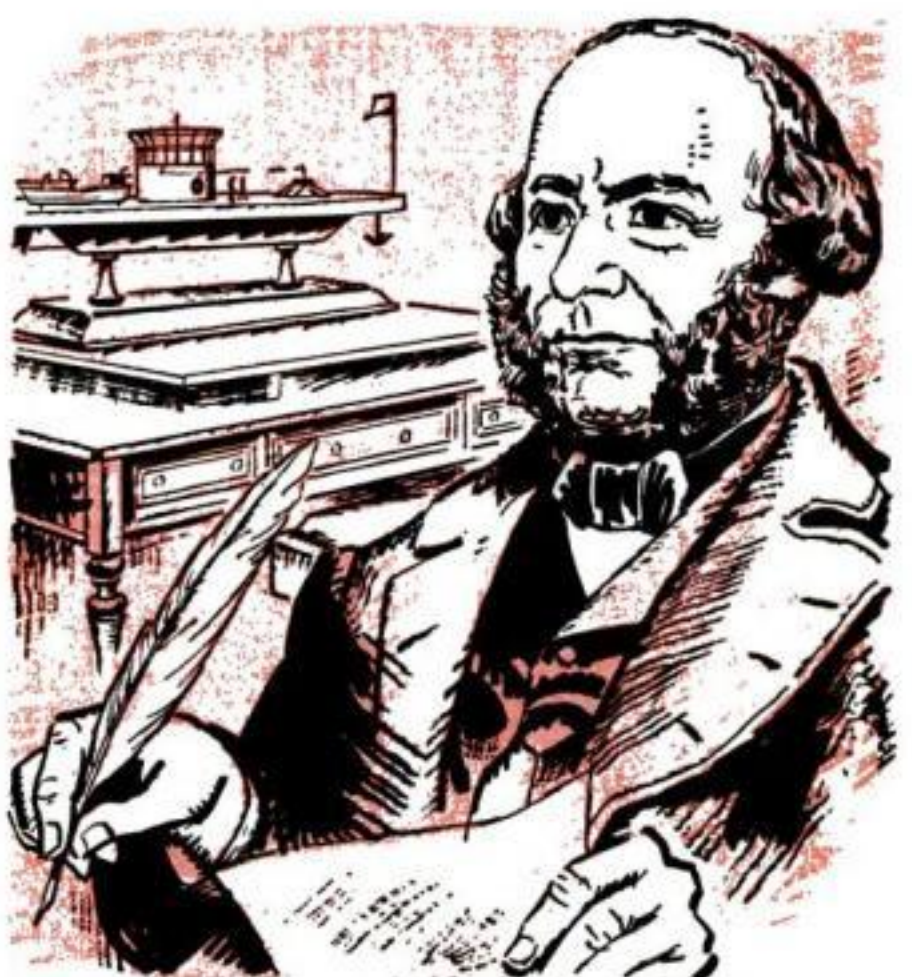
A grossly one-sided contract required Ericsson to build the ship in 100 days, but to be paid only 75 percent of its \$275,000 price (a third that of a frigate's) until the Navy had accepted it. The test

was to be exposure to enemy fire. Should the Navy reject the ship, all funds paid were to be returned.

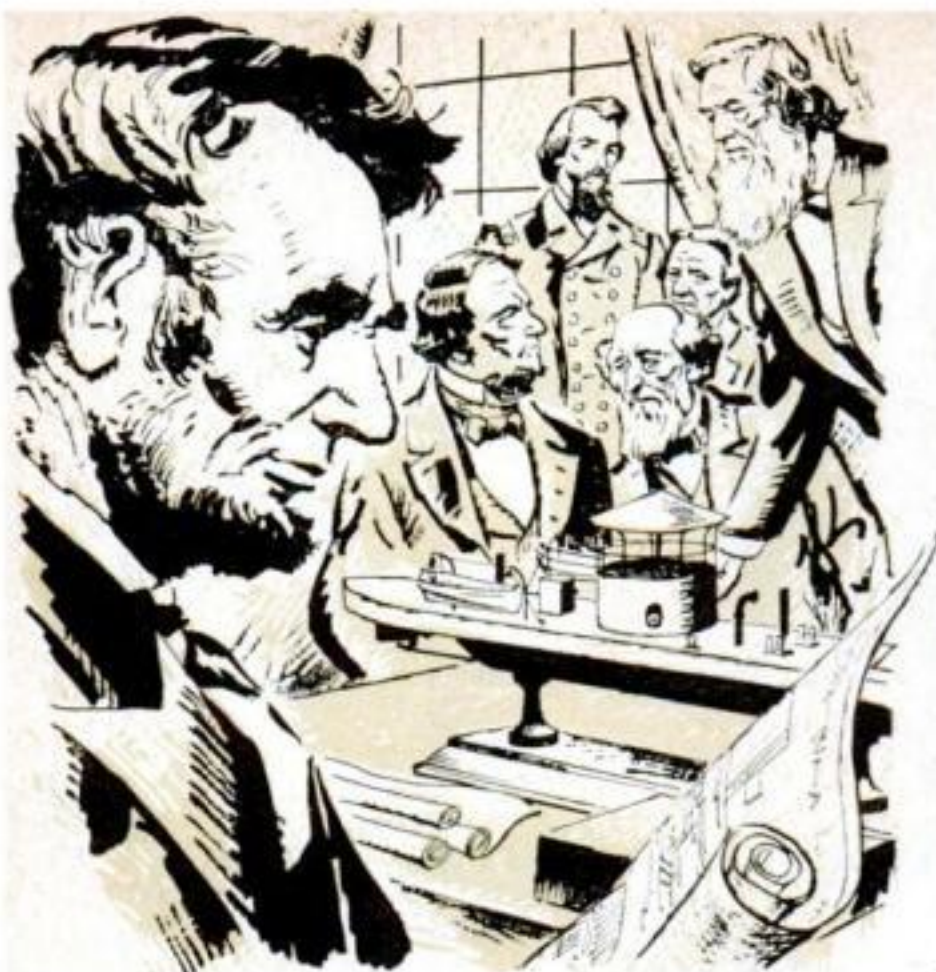
The contract called for masts and sails on the ship, but Ericsson ignored this. Just 132 days after her keel was laid, the Monitor steamed south to her rendezvous with history.



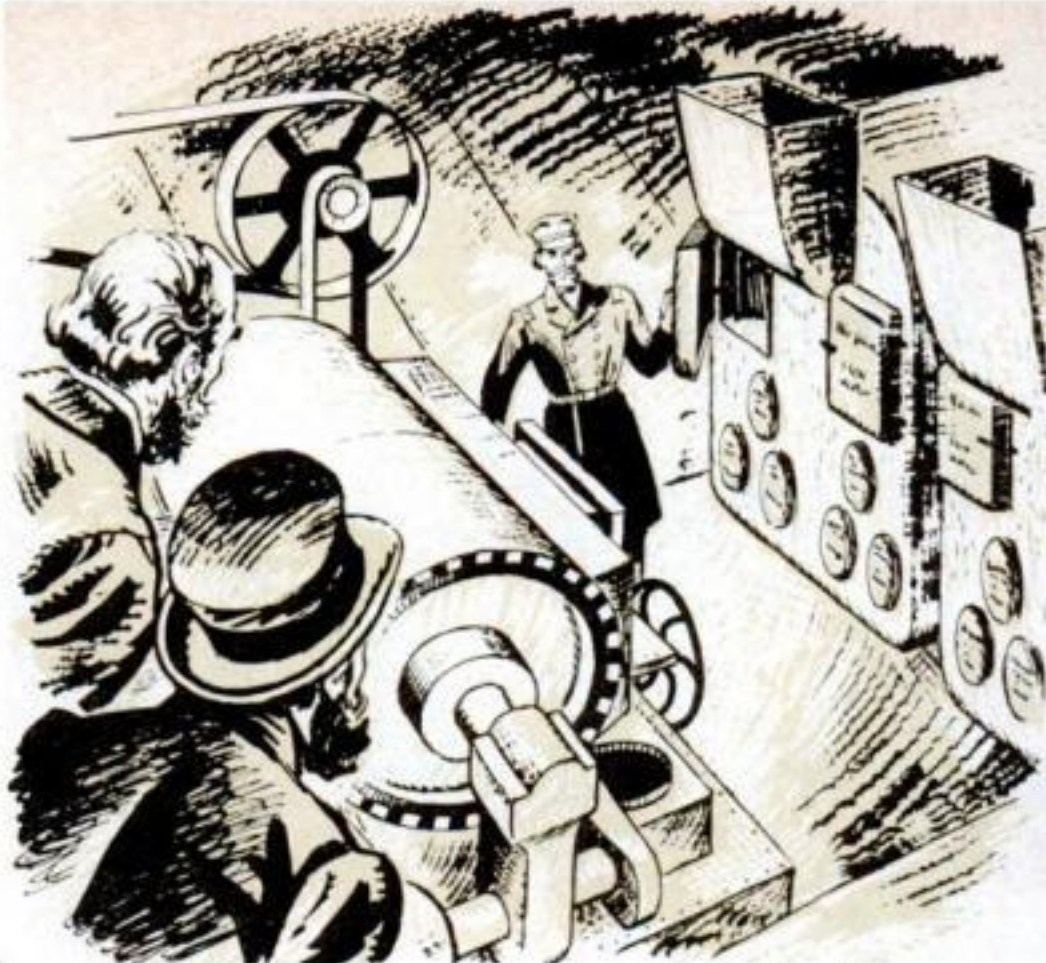
APRIL 19, 1861 At Norfolk Navy Yard, U. S. steam frigate Merrimack lay with engines dismantled as secession fever mounted. Union efforts to get the ship away failed. On the 17th, Virginia had seceded. Two days later Federal marines scuttled the ship, set time fuses to burn the drydock and 3,000 cannon. Southern troops saved these. The ship burned to the water line and sank, but was raised May 30 to join the Confederate navy.



AN ENGINEER WRITES Knowing that the Confederates were rebuilding the Merrimack as an iron-clad, the Union navy, with only wooden ships, advertised for plans of armored vessels and set up a board to consider them. Inventor-engineer John Ericsson responded with a letter to President Lincoln. He offered to build, in 10 weeks, a ship that would sink those captured by the South and safeguard the blockade.



PLANS ARE SHOWN The letter went unanswered, but a friend, Cornelius Bushnell, to whom Ericsson showed a model of the design, took it to Lincoln. The President convened the Ironclad Board to consider the idea, saying he knew little about ships "except flatboats, but this one seems flat enough," and "I think there's something in it." But only when Ericsson himself came did he get grudging approval from the board.



OCTOBER 1861 Work began at Greenpoint, Long Island, on Oct. 25. The 400-hp. engine had two cylinders, of 36-inch bore and 27-inch stroke, in a single casting crosswise of the hull. Bell cranks, 90 degrees apart to overcome dead center, were coupled to a single crankpin on the shaft. The four-bladed propeller was nine feet in diameter. Two boilers, located forward of the engine, were fed air by steam-driven blowers.



MARCH 8, 1862 Running unharmed past the U. S. frigate Congress, the Merrimac, now renamed the Virginia, poured a hot fire into the U. S. sloop Cumberland, whose cannons had no effect on the ironclad. Then the Virginia rammed. The Cumberland sank with a loss of 121 men. Little damaged, the Virginia next shelled and burned the Congress, killing 136. A 14-year-old telegrapher saw the fight, flashed the news out.



ENEMY SIGHTED On picking up a pilot that night, the Monitor heard of the disaster. Arriving at Hampton Roads about nine p.m., Worden was ordered to assist the U. S. frigate Minnesota, grounded a mile from Newport News. She could not be freed. At 7:30 next morning, March 9, the Virginia was seen approaching. Worden hastily got the Monitor under way to engage the enemy as far from the Minnesota as possible.



AN ERA IS BORN Many doubted that the iron monster would float. But Ericsson, with others, stood on the deck as it slid into the water on Jan. 30, 1862. Work continued day and night to finish it, for the blockade situation was desperate. Poor valve setting and an overbalanced rudder were hastily remedied. On March 6, the Monitor, with a crew of 61 under Lt. John Worden, headed south, towed by a tug.



STORMY PASSAGE At noon of the next day, strong winds and rough seas forced water under the turret and through hawsepipes. As waves broke over the four-foot blower stacks, water made the blower belts slip and finally break. Fumes filled the engine room. Men struggling to make repairs were carried out almost asphyxiated. The tiller ropes tangled, making the ship unmanageable. Only a timely calm saved her.



BATTLE JOINED Two 11-inch smooth-bore guns in the turret, firing solid 168-pound shot, ripped iron freely off the Virginia. They could have done more had regulations not limited the powder charge to 15 pounds. The turret, a nine-foot-cylinder with walls eight inches thick, was seated on a bronze deck ring and turned by steam. Huge port stoppers had to be hoisted up each time one of the turret guns was fired.



DAVID AND GOLIATH For two hours the battle went on, the little Monitor ranging like a terrier about the bigger ship, her two rotating guns against the Virginia's ten fixed ones. Dodging the iron-clad's attempt to ram her, she tried to disable the Virginia's rudder. At times the ships were only feet apart. At 11 a.m. Worden withdrew temporarily from the battle to hoist a fresh supply of ammunition into the gun turret.

CONTINUED



A CRUCIAL HIT Meanwhile, the Virginia attacked the Minnesota, with little effect. The Monitor, though communication with the pilot was poor and the gunners lost orientation in the rotating turret, returned to the fight. About noon, with the ships only 10 yards apart, a shot struck one of the iron blocks of the pilot house. Blinded by fragments, Worden thought the damage serious, gave his crew orders to sheer off.

BATTLE'S END The roof of the pilot house had been knocked askew, letting in light that made Worden believe the damage greater than it was. The Virginia also withdrew. Lt. S. D. Greene, second in command, gave up a chase because the pilot house prevented firing directly ahead. The Monitor's turret had proved its worth: From its two guns the Virginia sustained 50 hits, but her 10 guns had struck the Monitor only 21 times.



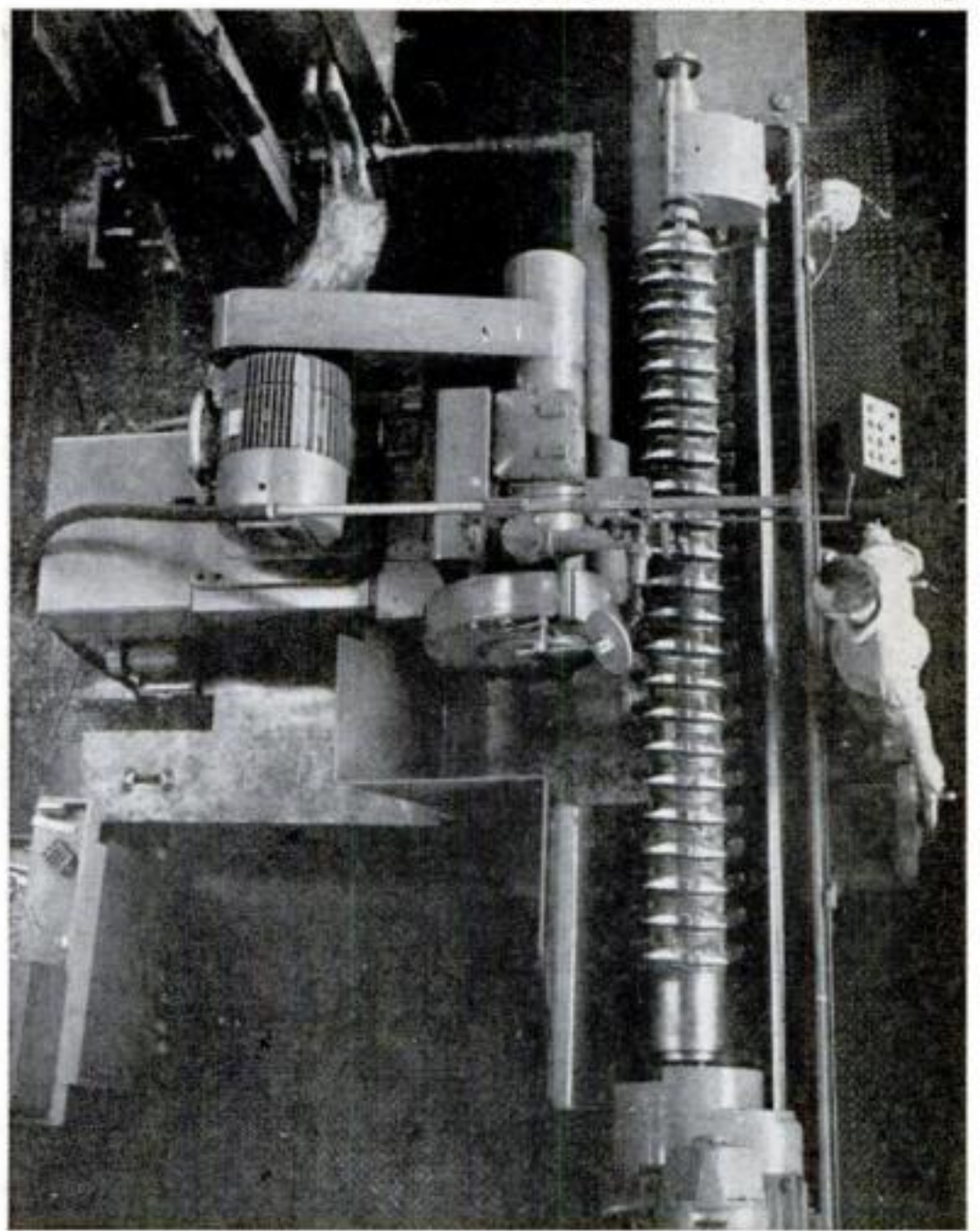
DECEMBER 31, 1862 While being towed by the Rhode Island off Cape Hatteras, the Monitor met a hurricane. The ship plunged under 40-foot waves. Two feet of water swirled in the ward-

room. At 11 p.m. she flew distress signals. Two boatloads were taken off, but the Monitor sank with 16 men. Small and barely seaworthy, she had saved the day for the Union—and sunk for all time the world's proud wooden navies.



Bus-seat indicator

Double-decker buses in Liverpool, England, have an electric panel at the entrance that indicates empty seats on the upper level, where standing is prohibited. It saves passengers from a vain climb and avoids congestion on the stairs. A microswitch in each upper-deck seat is operated by the weight of its passenger. It extinguishes the corresponding light on the panel when sat upon.



Giant grinder

This is how a new roll grinder, resembling a lathe, would look to a bird perched in the rafters of the Baker Perkins, Inc., machine shop in Saginaw, Mich., where it's installed. It handles diameters from 1 to 24 inches, lengths up to 10 feet.



In slot, jacket off . . .



. . . picked up by edges . . .



. . . placed on turntable.

Newest slot machine

A padded slot in the front of new GE stereo consoles and two stereo portables enables you to place records on the turn-

table without leaving greasy fingerprints on the sound grooves. You pick the record up by its jacket, stick it in the slot, remove the jacket, and then do the rest of the handling by the edges.

POPULAR SCIENCE here presents the third article in its winter series on the 1961 crop of compact cars. In January we reported on 10,000 miles of driving in the Olds F-85; in February, on 10,000 miles in the Pontiac Tempest.

Now we can summarize the virtues and demerits found in the spirited new Dodge compact, the Lancer. This car, a fancied-up brother to the Plymouth Valiant, was also driven 10,000 miles—the equivalent of a year's service—

Testing the New Little Dodge: 10,000

By Devon Francis

THE first editions of U. S. compact cars, introduced a year and a half ago, had fairly small engines. The cars were fairly economical to run. Their performance was somewhat tepid.

Inevitably, the major manufacturers have begun to break the pattern. The Dodge Lancer is compact, all right. Its normal engine size is within acceptable

limits. But from there on, any resemblance between the optional Lancers you can order and the first-generation compacts is purely coincidental.

In the version that **POPULAR SCIENCE** bought, the Lancer is a bomb—and it's *not* economical of gas. It couldn't be, with the transmission, engine, and axle ratio chosen. To satisfy our curiosity as to what a souped-up version of a compact would do, we sacrificed economy to

HOW THE LANCER DID



THE PERFORMANCE

Total distance covered . . .	10,017.1 miles
Gasoline used (non-premium) . . .	614.5 gal.
Average miles per gallon	16.3
Oil burned	4 qts.
Gas mileage at constant speeds	
30 m.p.h.	21.8
40 m.p.h.	20.8
50 m.p.h.	18.4
60 m.p.h.	16.1
Gas mileage in stop-and-go driving . .	13.8
Acceleration	
0-60 m.p.h.	11.2 seconds
40-60 m.p.h.	5.5 seconds
50-70 m.p.h.	7 seconds

Top speed	92 m.p.h.
Speedometer error	
Indicated Speed	Actual Speed
40 m.p.h.	39 m.p.h.
50 m.p.h.	49 m.p.h.
60 m.p.h.	58 m.p.h.
70 m.p.h.	68 m.p.h.

THE COSTS

Gasoline	\$201.55
Oil burned	1.60
Gas-oil cost per mile0203
Repair and maintenance, including adjustments at 500, 1,000, 5,000, and 10,000 miles	
Oil and filter changes .	\$12.00
Lubrication	6.00
Tune-up (parts)	12.50
Total labor	14.50
Total	\$45.00
Overall direct operating cost per mile	\$.0246

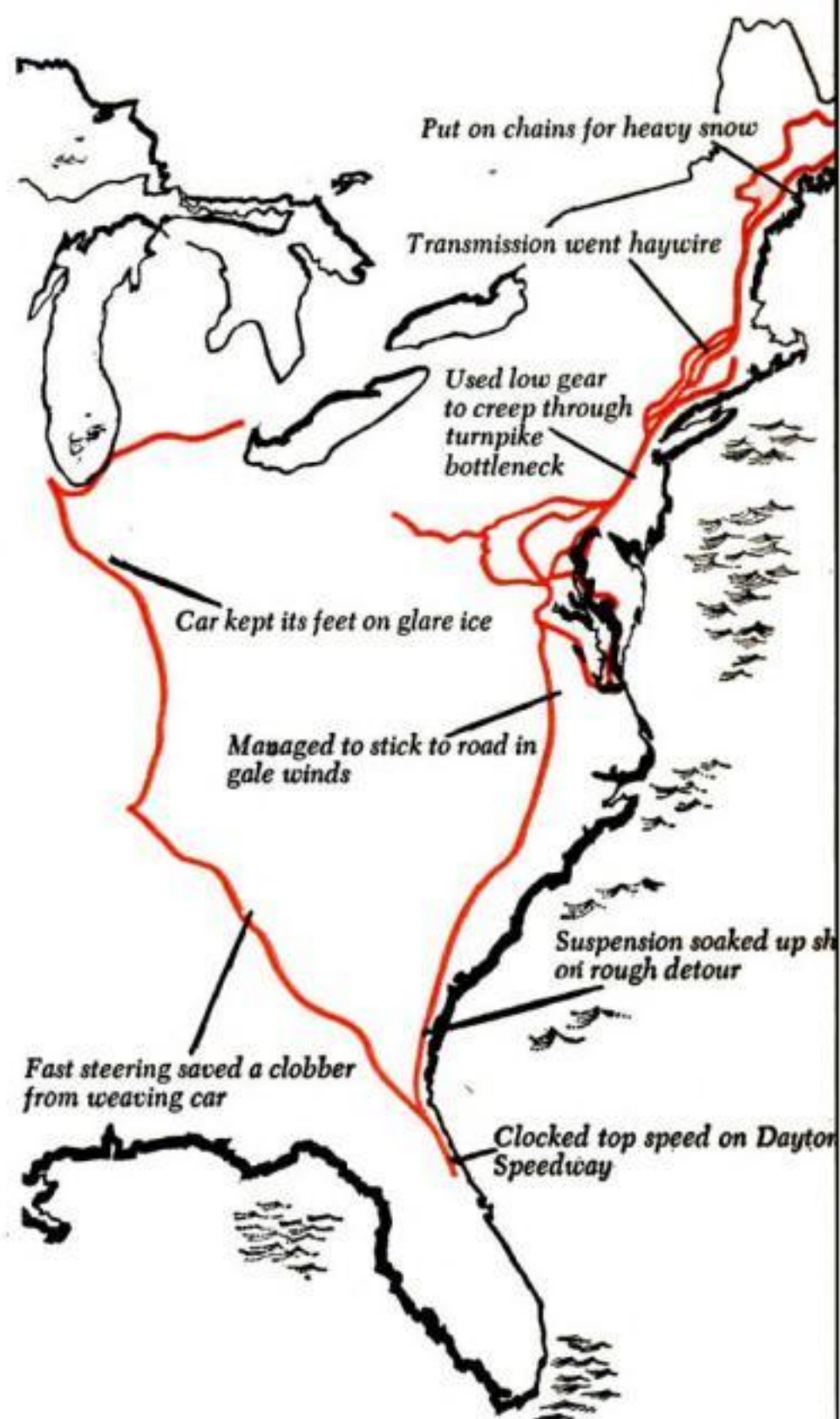
in one month. The story of how it stood up starts below.

The Lancer was purchased at its full retail price (\$2,963 including Michigan sales tax) from a regular dealer. It was a four-door wagon, with heater, radio, outside mirror, and windshield washers as accessories. Unlike the five previous test cars, however, it was "loaded." It had the optional 225-cubic-inch engine, a three-speed automatic transmission, power steering, and a hot 3.9 rear axle.

Miles in a Lancer

performance. Needless to say, the Lancer *does* come in mechanical renderings that are less eager, less boisterous, and a lot easier on fuel.

A half-dozen staff members drove the Lancer 10,000-odd miles. Their areas of agreement on its general characteristics were large, although minor dissents did crop up. The car developed one bad spavin. It will be described in the following round-table discussion.



Lancer's log included 20 miles at sea—a cruise aboard ferry linking the mainland with Virginia's Eastern Shore.

CONTINUED



*How do you average 400 miles a day if 18 inches of snow fall overnight?
Answer: with shovel, chains, and urgency.*



On Daytona track, top speed of car, still stiff at 2,000 miles, was 87 m.p.h. At 6,000, it had loosened up enough to hit 92.

Fuel Consumption

Frank Rowsome Jr.: In something more than 1,700 miles, I registered about 16½ miles to the gallon.

Howard Allaway: I got less—14.3 in stop-and-go around town, and 15.7 on the highway.

Ken Fermoye: Let's bear in mind that this car had the big 225-cubic-inch engine—essentially the one in the Plymouth six. And it had a 3.9:1 "performance" axle.

Rowsome: And consider the conditions. I drove in bitter cold at high speed. For some stretches I had to use chains in heavy snow.

Allaway: I got into slush and ice. Let's also bear in mind that an automatic transmission always costs gas.

Handling

Al Lees: I kept asking myself, "This is driving?" What with pushbutton transmission and feather-touch steering, all you have to do is aim it. I've never had my hands on a station wagon that caused less sweat in traffic.

Martin Mann: That may well be, but the steering was too fast for me. I never could get my corrections fine enough to maintain a comfortable course down a straight expressway. I suspect this might be dangerous for an inexperienced driver on a slippery road.

Alex Markovich: I'll concede that you have to get used to the steering. If that's a fault, the car has compensating traits. It shows no skittishness in snow. It cor-

How the Lancer compared with PS's Tempest, F-85, and 1960 Corvair, Falcon, and Valiant

	Lancer	Tempest	F-85	Corvair
Overall average miles per gallon	16.3 m.p.g.	20.25 m.p.g.	20.21 m.p.g.	23.43 m.p.g.
Gas mileage at constant speeds				
30 m.p.h.	21.8 m.p.g.	28.4 m.p.g.	27.9 m.p.g.	26.6 m.p.g.
40 m.p.h.	20.8 m.p.g.	27 m.p.g.	26.8 m.p.g.	24.2 m.p.g.
50 m.p.h.	18.4 m.p.g.	24.9 m.p.g.	24.9 m.p.g.	23.6 m.p.g.
60 m.p.h.	16.1 m.p.g.	22 m.p.g.	21.6 m.p.g.	22.6 m.p.g.
Miles per gallon in stop-and-go driving	13.8 m.p.g.	18.7 m.p.g.	15.03 m.p.g.	21 m.p.g.
0-60 acceleration	11.2 sec.	13.5 sec.	13.8 sec.	17 sec.
Top speed	92 m.p.h.	96-plus	100-plus	88 m.p.h.
Total oil consumption	4 qt.	1 qt.	4 qt.	4 qt.
Gas-oil cost per mile	\$.0203	\$.0163	\$.0162	\$.0145
Overall direct operating cost per mile	\$.0246	\$.0186	\$.0172	\$.0184

NOTE: Lancer bought by PS had optional larger engine, automatic transmission, 3.9



Slammed along frozen Maine back roads, the Lancer handled well, rarely bottomed.

ners well. There's practically no body lean in tight turns. The brakes are fine.

Fermoyle: The weight balance is good. The rear wheels stick to the pavement like egg yolk to a plate. Personally, I like the fast steering. At one point, when another car cut in front of me, it saved me from trouble.

Allaway: To me the Lancer was not only quick but sure-footed—as if running in sneakers.

Rowsome: That's how I felt. Even on rough roads, going too fast, it kept its feet. When you do get it going a little sideways, it wants very much to straighten up. As for the steering, it's unquestionably nutty to have power steering in a comparatively light car like this. But I like the quicker ratio that is fitted with power on Chrysler-built cars.

How the Lancer's Tires Stood Up

At 11,040 miles, a tire expert measured the Lancer's 6.50 x 13 Good-year tires. He found that just a shade less than 30 percent of the tread had been worn off the front tires and a full 30 percent off the rear ones. The four tires had been rotated at 5,105 miles. The spare had not been used. On that basis, four tires would have lasted for 30,000 miles, and five for 37,500.

The Ride

Fermoyle: I prefer a ride that's a little stiff rather than soft. The Lancer's suited me fine. There's a little bit of pitching on wavy, choppy surfaces.

Markovich: The shocks are firm. They

CONTINUED

Falcon	Valiant
26.56 m.p.g.	20.31 m.p.g.
30.2 m.p.g.	25.8 m.p.g.
29 m.p.g.	24.2 m.p.g.
28.1 m.p.g.	23.9 m.p.g.
27.1 m.p.g.	22 m.p.g.
22.4 m.p.g.	19.6 m.p.g.
22.9 sec.	17 sec.
78 m.p.h.	96 m.p.h.
1 qt.	3 qt.
\$.0122	\$.0163
\$.0147	\$.0206

"performance" rear axle.

Wagon felt sure-footed on snowy or icy roads. Partially completed Pittsburgh Auditorium is in background.



How the Same Lancer Performed with a Standard Rear Axle

After completing the 10,000-mile test run in the Dodge Lancer with its special factory-fitted 3.9:1 "performance" rear axle, PS wondered how the car would have behaved with less jack-rabbit gearing. So we changed it to a 3.23:1 gear.

This change of roughly 20 percent brought the car to the area of normal gearing, but it was in no sense extreme. A 3.23 axle in a comparatively light car with a 225-inch engine is hardly undergeared.

We then drove the car an additional 1,276 miles, remeasuring performance and fuel consumption. Here are the results:

Psychologically, the way the car felt after the change depended on recent experience with the high-performance axle. Those who had put on high mileage with the "hot" gear felt at first that the car had become sluggish. After an hour or two the impression faded. Correspondingly, those accustomed to the earlier ratio felt that the engine and transmission had become much smoother. Starts from a stop were more pleasing.

Consensus of the drivers who had experience with both axle ratios: Except for people who travel hilly country with heavy loads, or who have an acute need for jazzy acceleration, the 3.23 axle makes



far more sense in this car when equipped with this engine and transmission.

By stopwatch, the change brought these differences in performance:

	3.9 Axle	3.23 Axle
0-60 m.p.h.	11.2 sec.	15 sec.
40-60 m.p.h.	6.5 sec.	8.2 sec.
50-70 m.p.h.	8 sec.	12 sec.
Top speed	92 m.p.h.	100+ m.p.h.

In miles per gallon of fuel, the ratio change produced these results:

	3.9 Axle	3.23 Axle
Constant 30 m.p.h.	21.8	26.4
Constant 40 m.p.h.	20.8	24
Constant 50 m.p.h.	18.4	21.7
Constant 60 m.p.h.	16.1	19.6
Stop-and-go driving	13.8	15.7
Over-all gas mileage	16.3	19.2

give you a pretty smooth ride over any type of road.

Mann: The ride is comfortable—and in the back seat, too, according to my kids. But on a certain combination of wavy blacktop and 65-m.p.h. speed, there's a weird diagonal rocking. The front end dives over on one wheel and then the other.

Rowsome: That didn't show up for me. I found the ride delightful on horrible roads, on holes, wallows, ruts, and loose stones. It's just a bit thuddy on medium-fair roads.

Allaway: The ride's as good as the F-85's and far superior to the Tempest's.

Performance

Markovich: There's lots of torque.

Rowsome: There's an understatement for you. The car's a tire-chirper.

Markovich: As I was about to add, the acceleration is great in all speed ranges. The standing-start acceleration is terrific, especially when you shift 1-2-D on the buttons.

Rowsome: This particular axle and

[Continued on page 234]

How Well Was It Designed and Built?

Despite its corporate kinship and styling, the Dodge Lancer is not a Plymouth Valiant in different dress. It has a character of its own. First and foremost, it's better built. But like all cars, it has its faults. Here are some:

- The automatic transmission had to be repaired after 5,000 miles, apparently because it had not been tailored to a high-performance axle. Moreover, it refused to upshift when stone-cold.

- The gas capacity is too low. A 500-mile day required three refuelings.

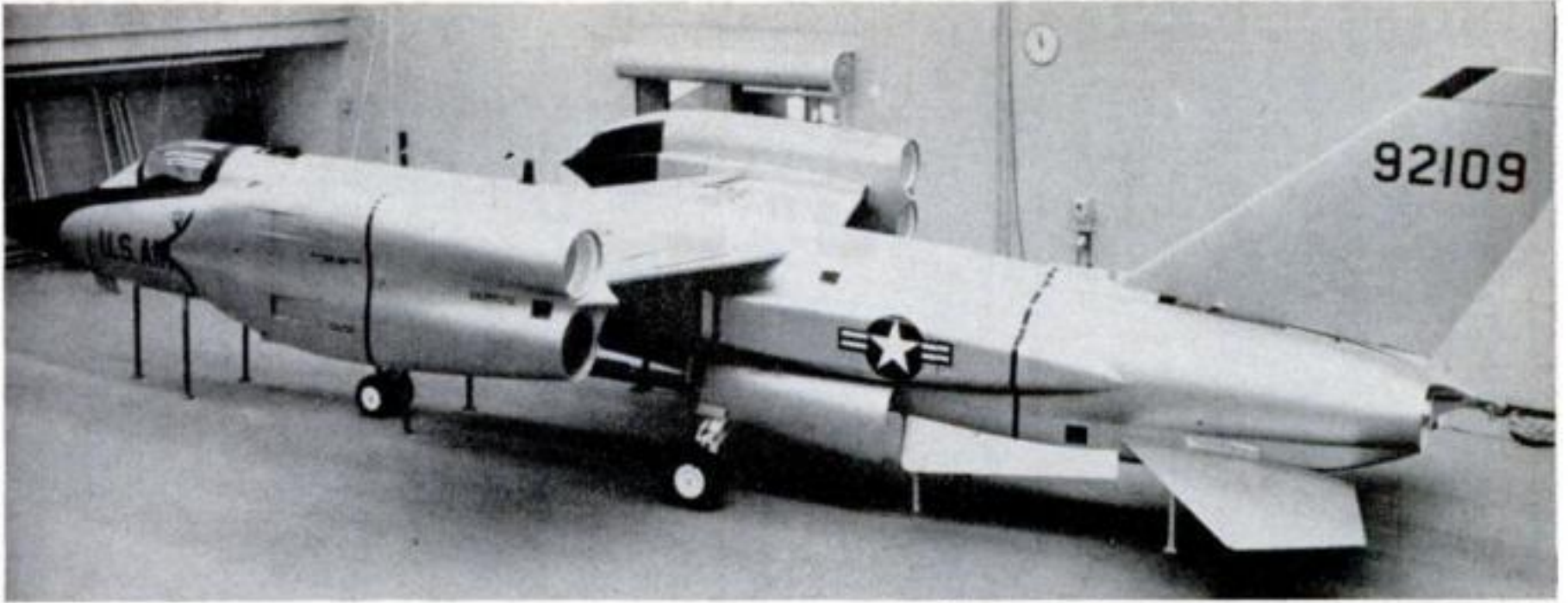
- The rear roof overhang sucked up muck on the tailgate glass.

- The ash tray is poorly designed and awkwardly placed for the driver. At night, panel lights reflect in the windshield.

- Certain vent-window settings caused a wind whine at high speeds.

- A secondary park lock failed to work under roll-back loads.

- Finally, the station-wagon body seemed to be slightly too limber.



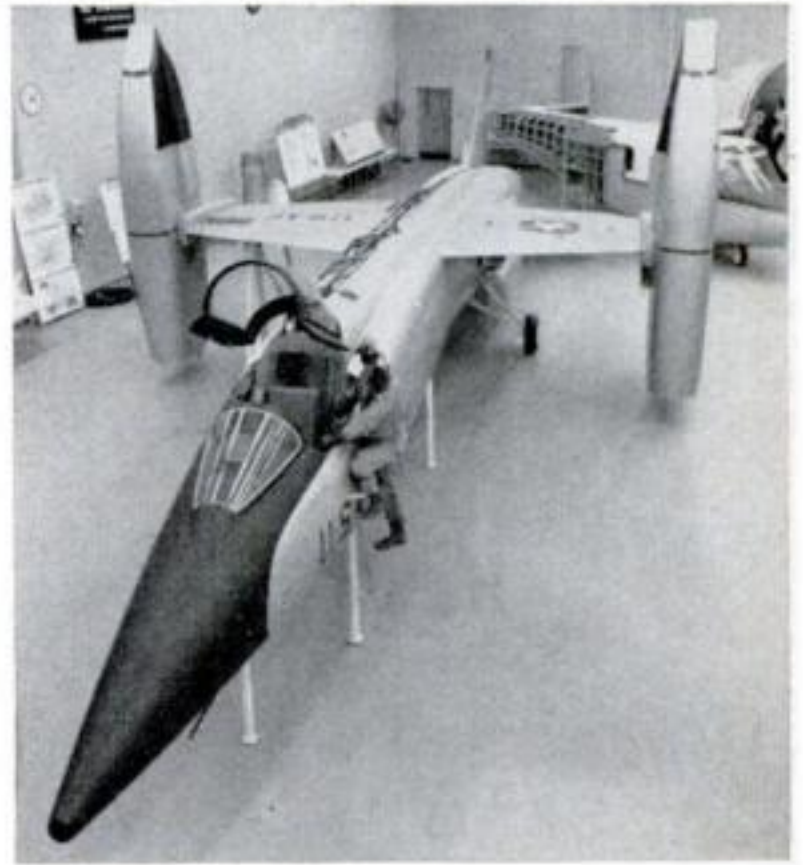
Wing jets turned for horizontal flight . . .
 . . . in position for vertical takeoff.

Eight-jet fighter-bomber can take off from a dime

The Air Force and Navy may soon have a supersonic fighter-bomber that can take off from, and land on, a helicopter landing pad.

The single-place VTOL Bell D188A is designed for eight turbojets: two that rotate at the end of each short, knifelike wing, two in fixed horizontal position in the tail, and two set vertically through the fuselage behind the cockpit, covered by flaps when not in use.

The plane would reach an altitude of 61,000 feet in 60 seconds, attain a speed of Mach 2.3, more than twice that of sound. A full-scale mock-up has been built under contract.



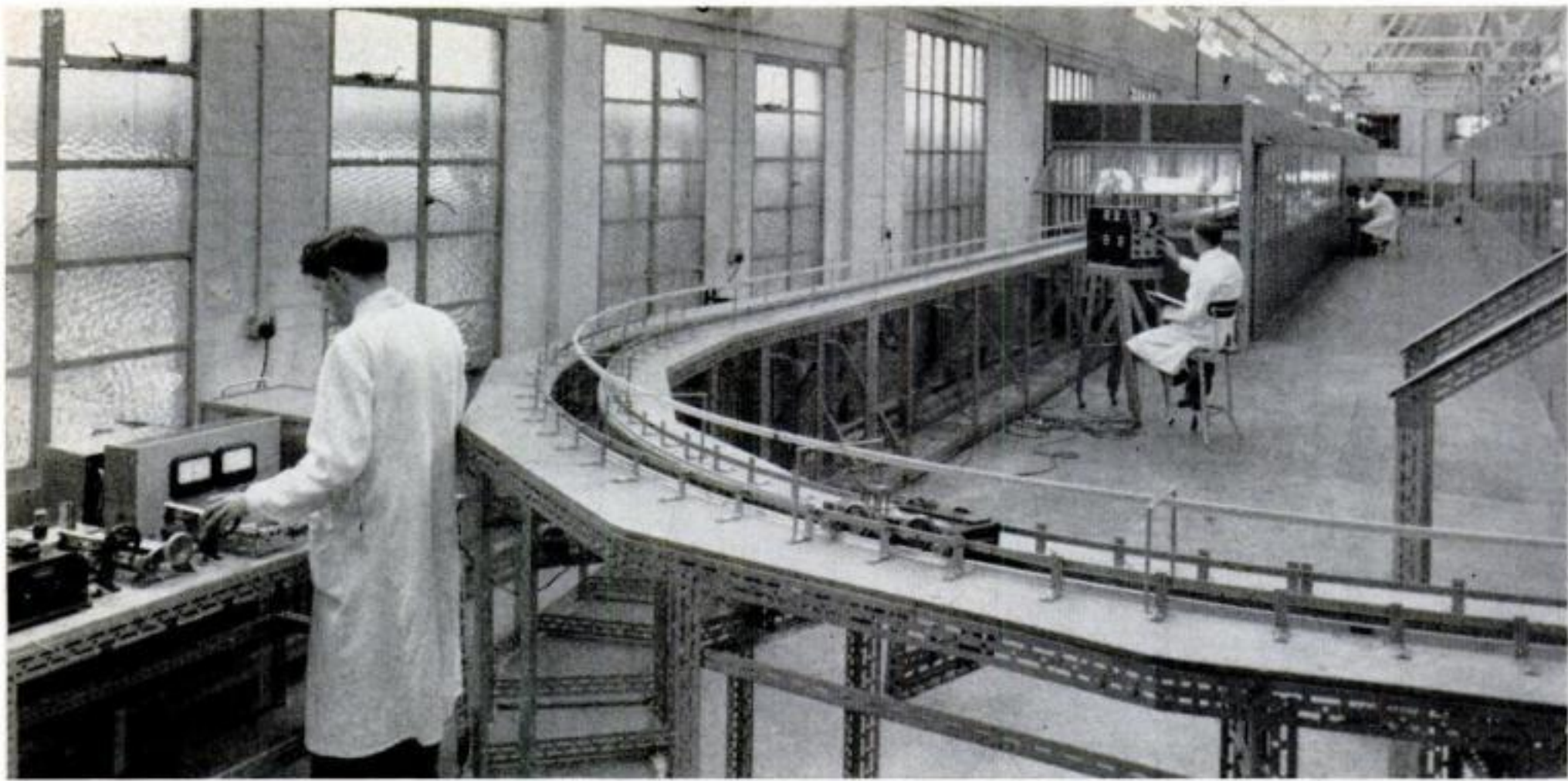
Big load for little wagon

Britain's Austin and Morris 850 station wagons may be only 11 feet long, but their 35½-cubic-foot cargo compartments can hold a lot of freight. By actual count, this one held a trunk, 12 suitcases, a picnic table, 9 folding chairs and stools, a baby carriage, and other odds and ends. The battery and spare wheel are recessed under the floor.



Designed for learning

This spectacular group of buildings is the new Domestic and Trades College at Manchester, England. The college, built at a cost of \$1,680,000, combines under one roof departments previously scattered about the city in five buildings. Trades as diverse as baking and wigmaking are taught. There is a restaurant in which student chefs test their dishes.



MODEL TRACK has two test sections housed in temperature-controlled enclosures located along the 80-foot straights. Track uses $\frac{5}{8}$ " flanged aluminum rails mounted on a steel structure

four feet high. Different overhead-wire systems can be installed in each test section for comparative study. Pantograph rides against nylon bar outside the test sections.

Model Trains Show How to Build Big Electrics

MODEL electric trains scooting around a track at a scale speed of 100 m.p.h. are showing English train designers how to build big electric trains that will never get caught with their panto-

graphs down. One big problem: feeding juice from an overhead trolley wire 16 to 25 feet above the tracks to a locomotive traveling at high speed.

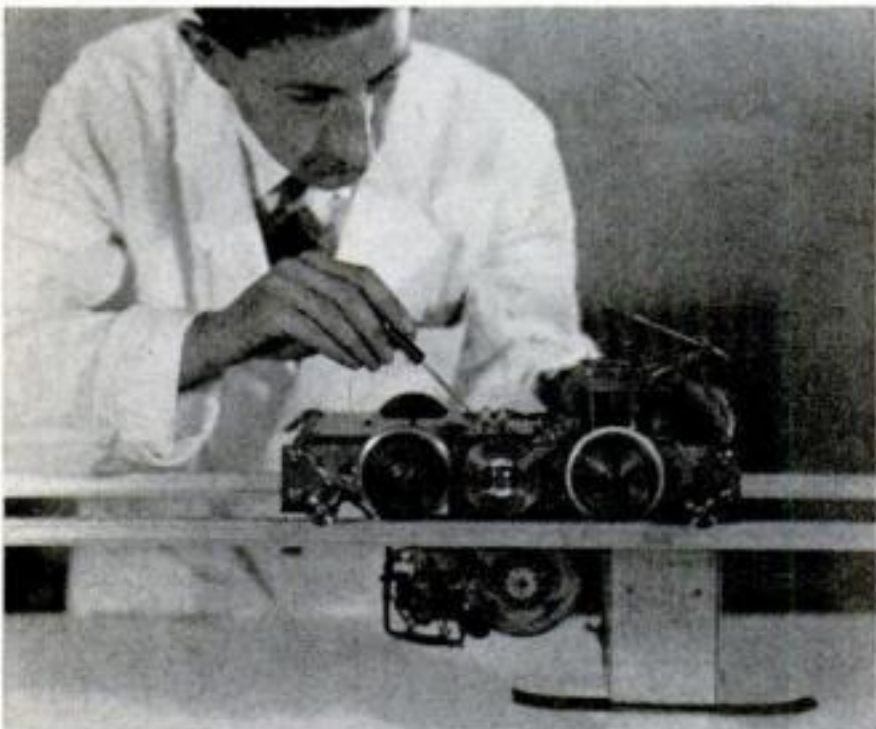
Part of the problem is the pantograph, alternately shrinking and stretching to keep the shoe in contact with the wire.

- It must be light, to keep inertia effects to a minimum.

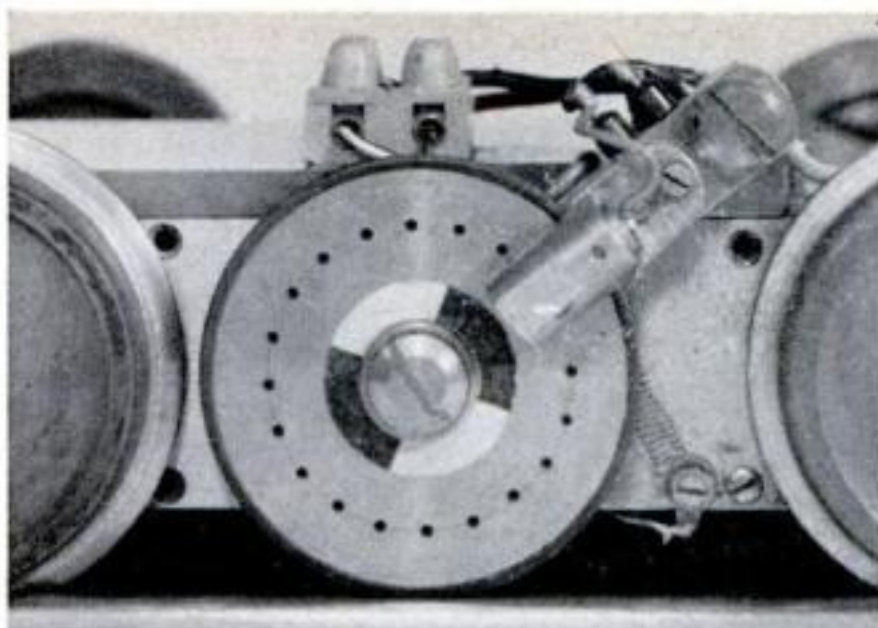
- It must be strong, to resist high wind pressures and stresses due to the sway of the locomotive.

- It must be flexible. The effect, when the wire changes height to go under an overpass, is comparable to hitting a sharp rise or dip in the highway when you're driving your car at high speed.

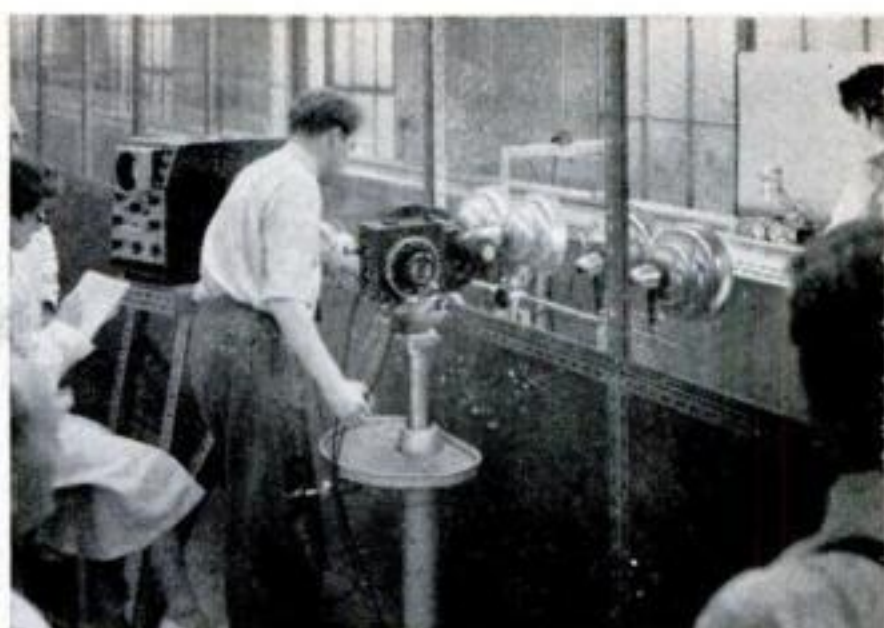
If the contact shoe leaves the wire, or bounces several times as your car wheels usually do, destructive, high-current arcs occur that can quickly destroy both shoe and wire. Besides these big bumps, every point of support for the trolley wire makes a "hard" place that acts like a bump to the shoe pressing against the wire. And there's the wire itself: It sags between supports, so that its own flexibility and inertia must become major



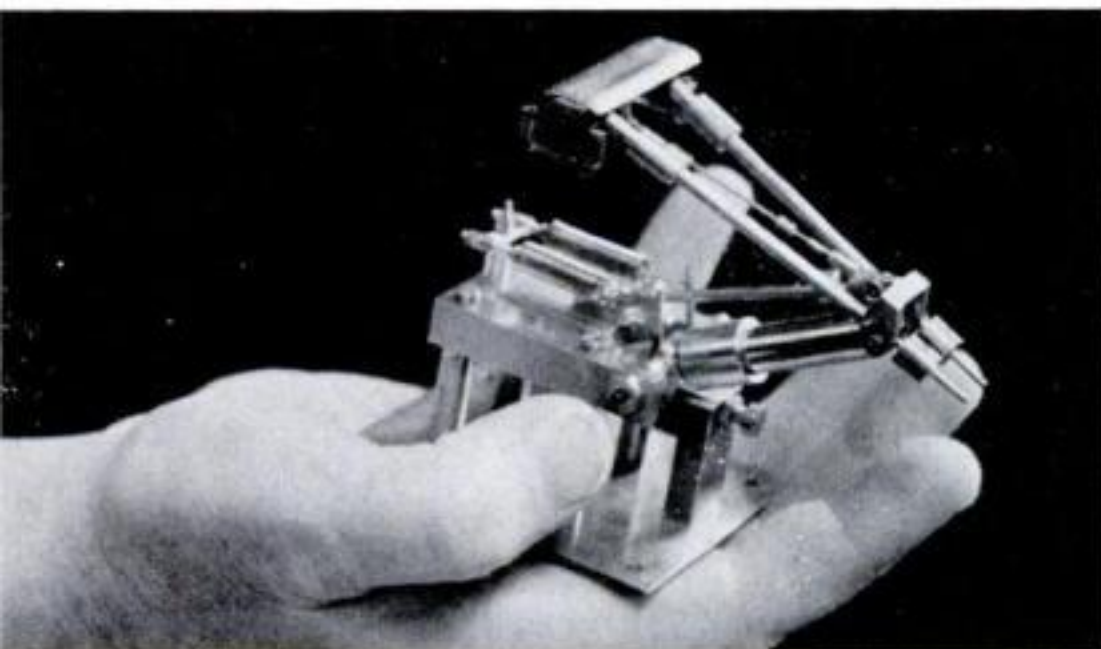
LOCOMOTIVE doesn't look much like the real thing, but the dynamic behavior of the critical parts is exactly duplicated. It is powered by a 50-volt DC motor, underslung to give stability. Speed, acceleration, and braking can be regulated automatically by the long curved shoe that operates microswitches placed underneath the track at appropriate locations.



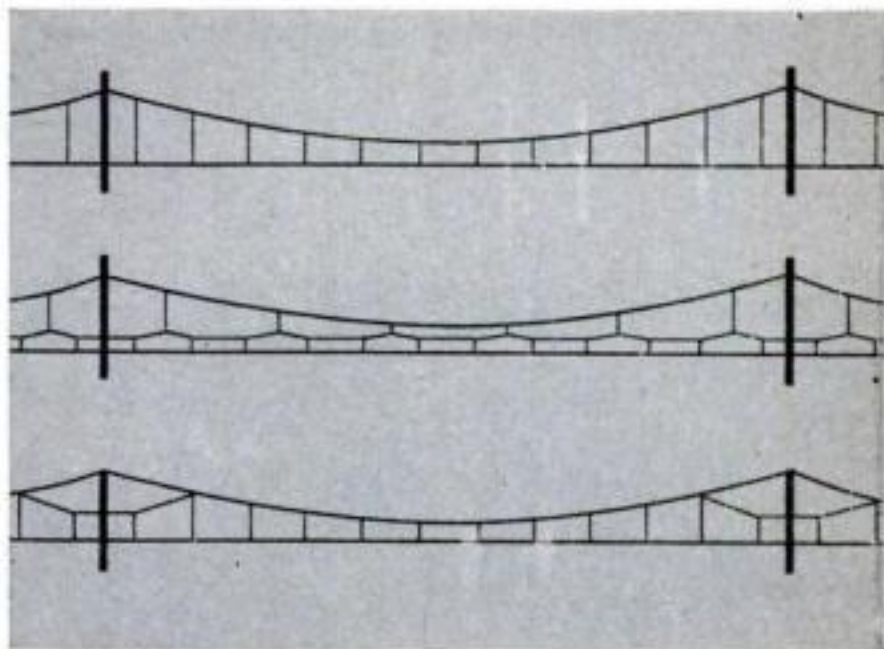
RUBBER-RIMMED FIFTH WHEEL measures the locomotive's speed. Light shining through the evenly spaced holes drilled through its rim falls on a photocell. The frequency of the resulting electrical pulses is proportional to speed. Pulses are radioed to a control panel where they operate a meter calibrated in feet per second. Another meter reads acceleration.



HIGH-SPEED MOVIE CAMERA at the control point records wire tremors and pantograph behavior as the locomotive races by. Electrical data signals received by radio and wire are displayed on a multitrace oscilloscope. A capacity pickup on the bridge over the track detects wire vibration. Enclosure permits observation under precisely controlled conditions.



MODEL PANTOGRAPH is an accurate scale reproduction of the collector assembly used on the British Railways 25-kv., AC system. Although tension of the springs varies with extension, special linkages give constant upward pressure of shoe against wire regardless of wire height. The model serves only for mechanical studies—it receives its power through the rails.



OVERHEAD WIRES are made up of tiny brass beads strung on fine wire to keep the correct scaled-down balance between mass and flexibility. Model support is also mathematically scaled—even its stiffness and distribution of mass. The sketches above show various suspension configurations typical of those being investigated by means of the model-railroad setup.

design elements in the complete system.

Housed in a special laboratory at Tolworth, England, is a precision model railroad, used by British Insulated Callender's Cables to study overhead-wire systems. All critical parts are accurately scaled for length, mass, and pressure to give test-bench reproduction, under controlled conditions, of actual-size running.

Scaling ratio for length is 32.5:1, so the 332-foot track loop is effectively more than two miles long.

The ratio for speed is 5.7:1, making the 18-m.p.h. top speed equal to an actual train speed of 100 m.p.h.

The mechanical functioning of the

pantograph is faithfully reproduced in miniature. Spring tensions, inertia, and center of gravity of each arm and contact shoe are exactly proportioned to duplicate the behavior of the real thing.

Overhead wires were the most difficult to produce, since the scaled-down balance between mass and flexibility had to be kept. The final solution was to thread cylindrical brass beads on fine brass wire. It takes a workman a full day to make one six-foot section. The catenary wires that support the trolley wire are of similar construction except that tungsten was used instead of brass wire.—*David Scott.*



Colorado's "Mobilab" for science teachers . . .

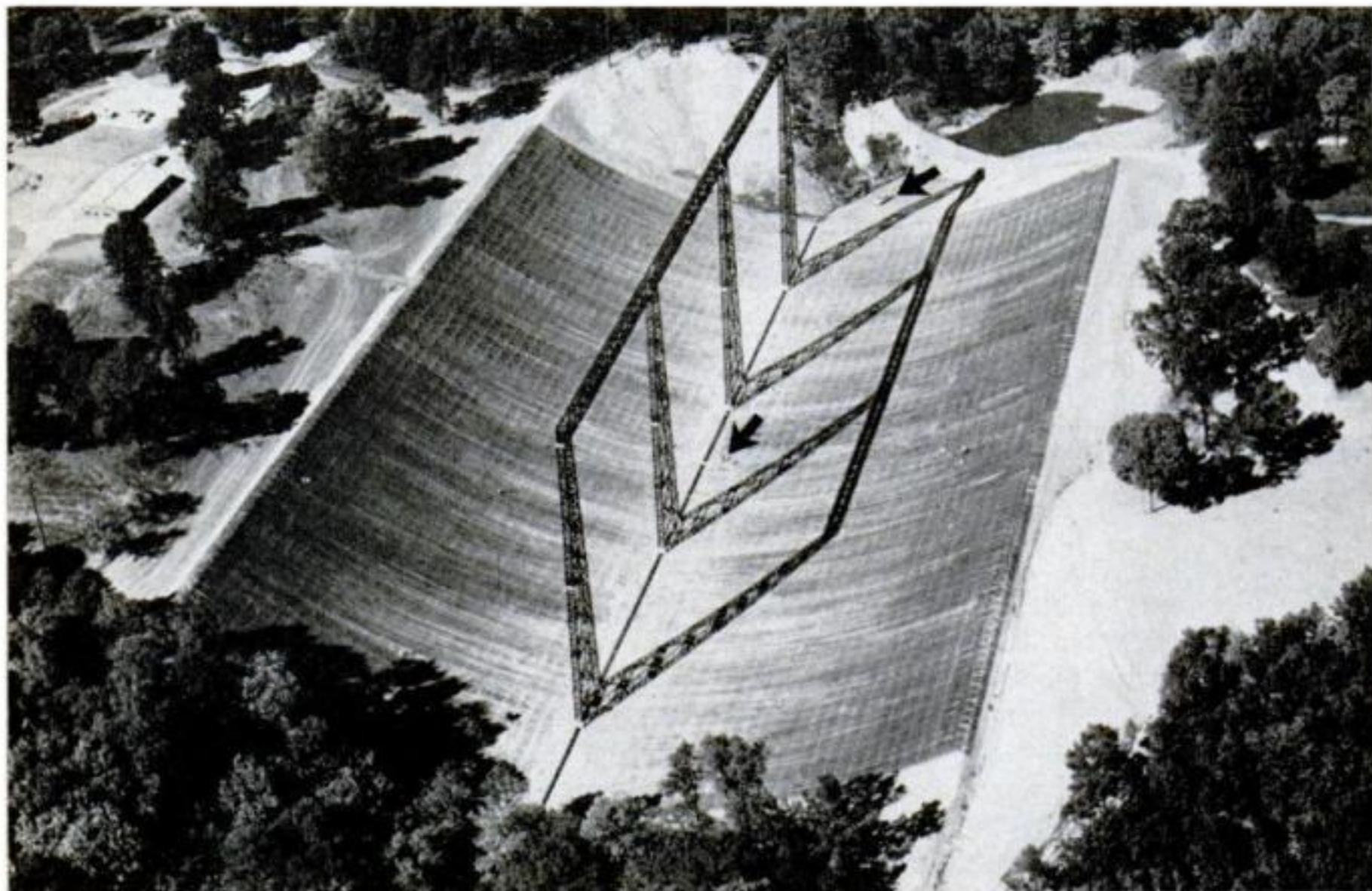


...gives three-day brush-up course.

Science laboratory on wheels

Rural teachers in Colorado's elementary schools now brush up on their science subjects in a classroom that comes to them. It's a 32-foot trailer that contains complete basic laboratory equipment to

accommodate 14 persons at a time. It stops three days in remote mountain and plains villages, enabling teachers to attend three three-hour refresher sessions under guidance of a specialist.



For signals from outer space

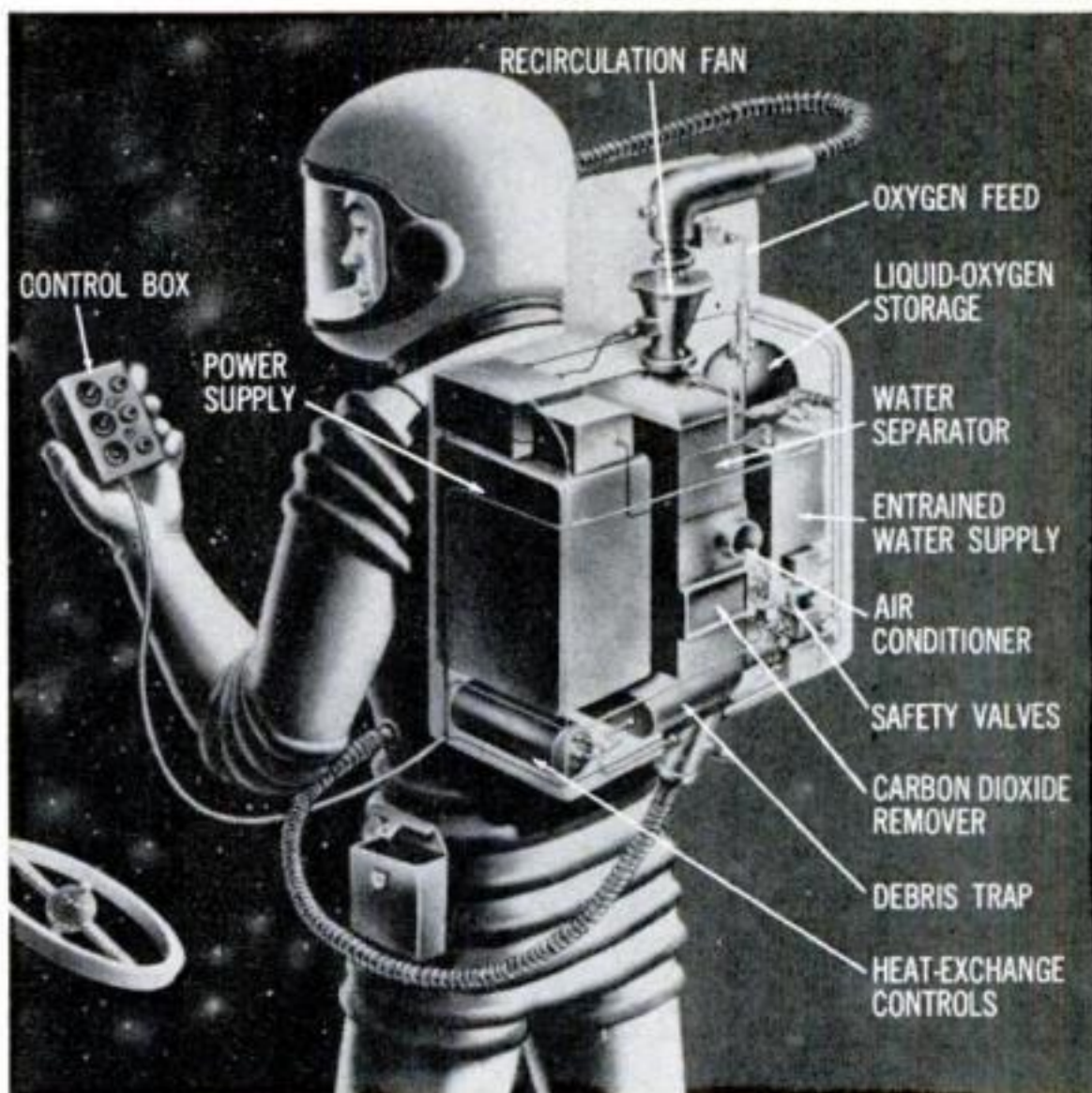
A new giant "radio mirror" is under construction by the University of Illinois in a ravine shaped to fit it five miles southeast of Danville. Its concave expanse is 600 feet long and 400 wide. A man and an automobile in the picture

above (arrows) give an idea of its immense size. Receiving units are supported on towers 165 feet high. Financed by the Office of Naval Research, the radio telescope with its huge parabolic reflector is designed to catch signals from space.



SEALED SUIT keeps out toxic fumes; pack on back supplies oxygen and air-conditioning.

CUTAWAY OF PACK shows oxygen tank and system for purifying air for six hours' breathing.



He carries his climate on his back

This suit contains its own supply of oxygen, and cools and heats itself for the comfort of its wearer. It was designed for handling toxic missile fuels, fighting forest and mine fires, rescue work, and for jobs where poisonous fumes are encountered. It could also be worn by crews of

high-flying planes and space explorers.

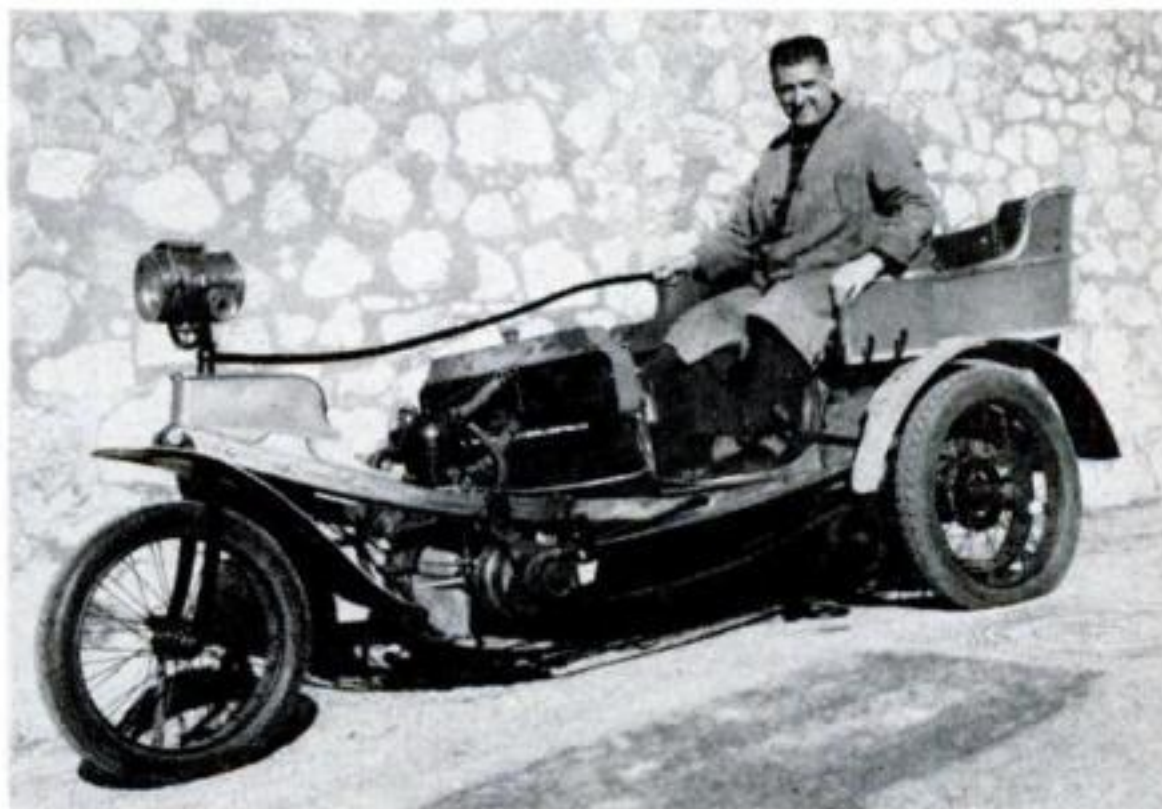
The suit holds a back-pack air-recirculation system developed by Garrett Corp.'s AiResearch division. It stores a six-hour supply of oxygen and air-conditioning equipment to warm or cool the wearer in extreme temperatures.



For the man who's all thumbs

This is a Swedish version of the pushbutton telephone. You press the buttons to get your number instead of twirling the dial.

The phone isn't yet on the general market: only for interoffice use at L. M. Ericsson, Ltd., its maker.



There's life in the old car yet

This 1898 Lacroix de Laville, one of the earliest French cars, was found recently on a farm in France. Long out of use, it was completely overhauled and made to run like new again by André Scoupe, shown at the wheel, who intends to enter it in antique-car races.



Legal Burglars Crack Safes for a Living

To keep a step ahead of crooks, manufacturers put their money chests through torture tests

by **Robert A. Kelly**

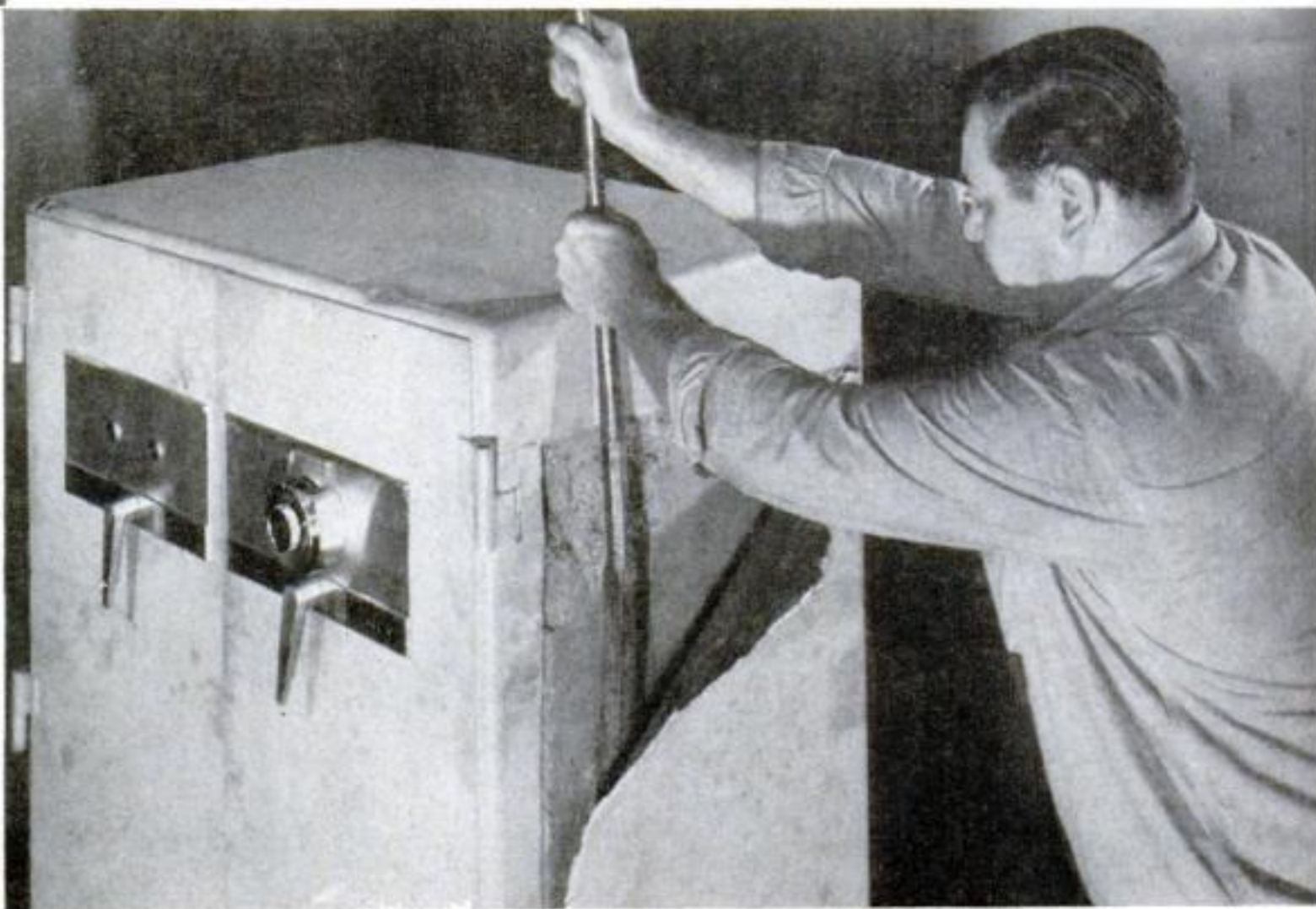
THE
OLD
WAY

EVERY day several dozen men throughout the U. S. batter and chisel away at safes. The safes range from small wall units to huge bank vaults. These safecrackers work under the approving eye of the safe manufacturers.

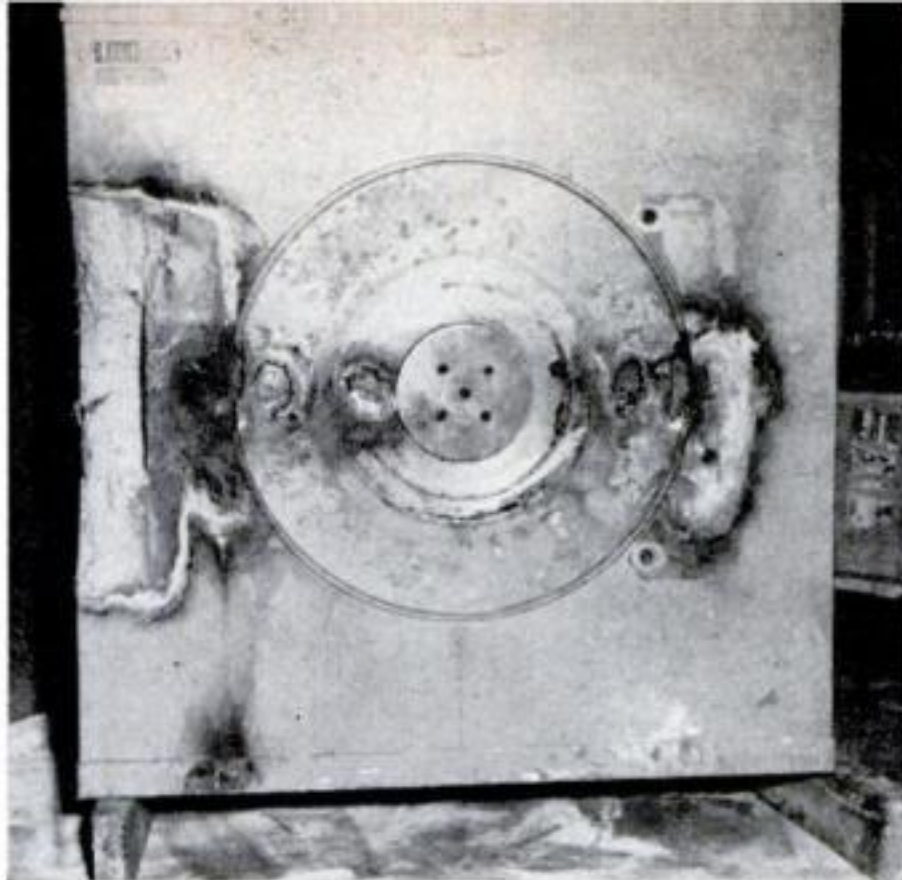
That's because it's legal. The men are paid to try to break into the safes. If they can crack a safe, so can a burglar—and back the thing goes to the design board.

ATTACKING THE DIAL on a modern safe (top) throws automatic door lugs into a locked position. Nitroglycerine (center) is risky; tumbler listening doesn't work.

THE
NEW
WAY



PEELING is a common technique of thieves. Outer metal covering is removed before direct assault on a safe's side wall. Here a new model gets the treatment from a professional safe torturer using a crowbar.



SAFES THAT COULDN'T BE CRACKED: Burning through in four different places was tried on the safe above by burglars. A heat-dispersing



copper insert plate foiled the attempt. Photo at right shows a safe with cash intact after a peeling and battering onslaught.

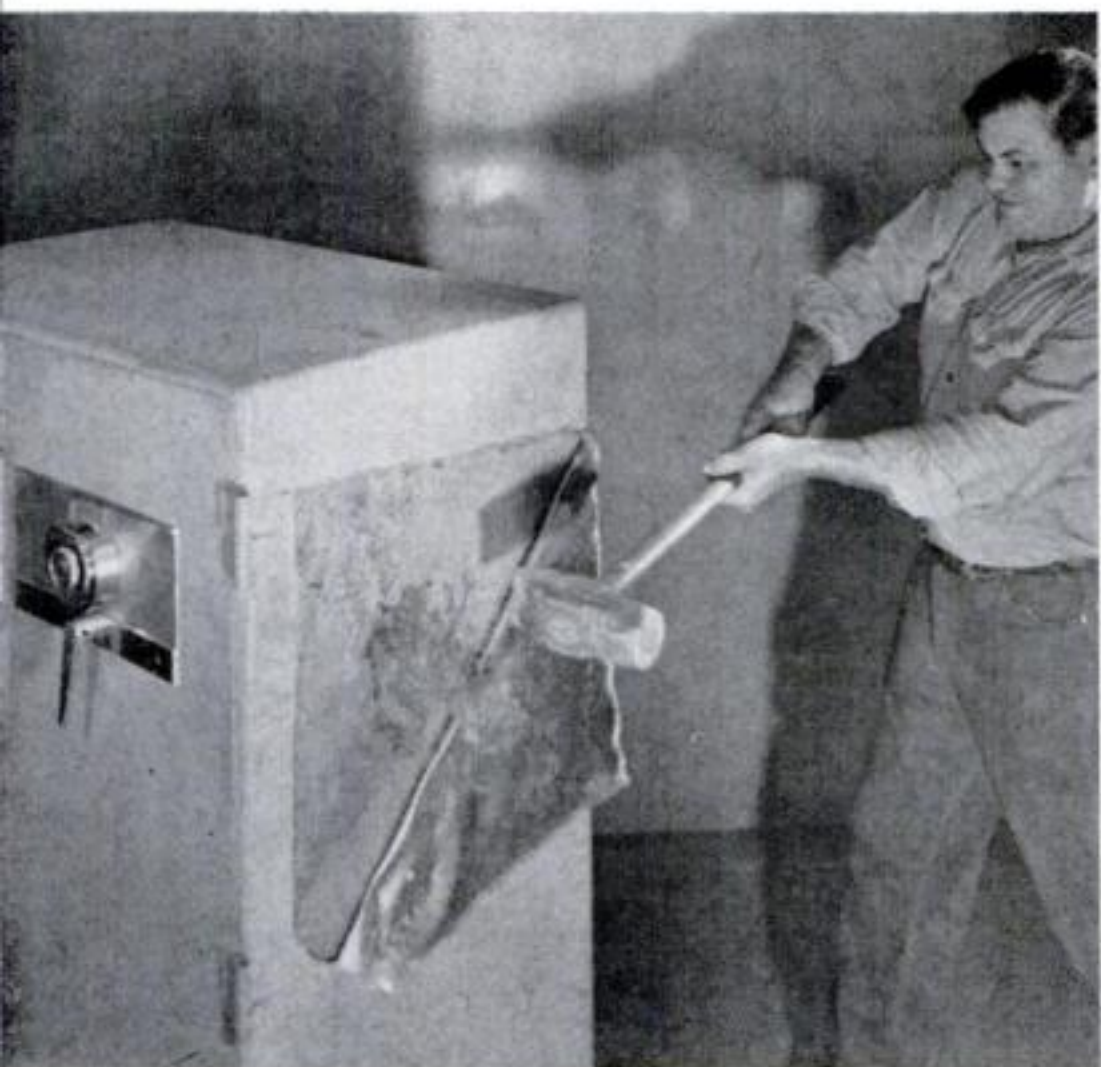
Countless robberies, and attempted ones, have provided the manufacturers with a thick book of knowledge on the techniques of professional burglars.

Tricks of the trade. One type of "cracker" will attack the combination dial, using a variety of tools. Occasionally he will put a flaming acetylene torch to it.

Crackers like that are the amateurs. The locking mechanisms of today's safes

—thanks to the testing by legal burglars—are built to freeze if anyone tries to force the dial. Explosives—on big safes, anyway—are old hat, too. The safemakers long ago inoculated their products against nitroglycerine.

A bungling burglar breaking into a Kent, Ohio, market packed hams and other cuts of meat around the safe to muffle the explosion. When he set off the charge, it blew the roof off the building,



BATTERING is the next step after peeling. If this sledge-hammer pounding fails to gain entry the safe is considered burglarproof.



ACETYLENE TORCH, a standby with most professional safecrackers, is often resorted to after peeling and battering have softened a safe.



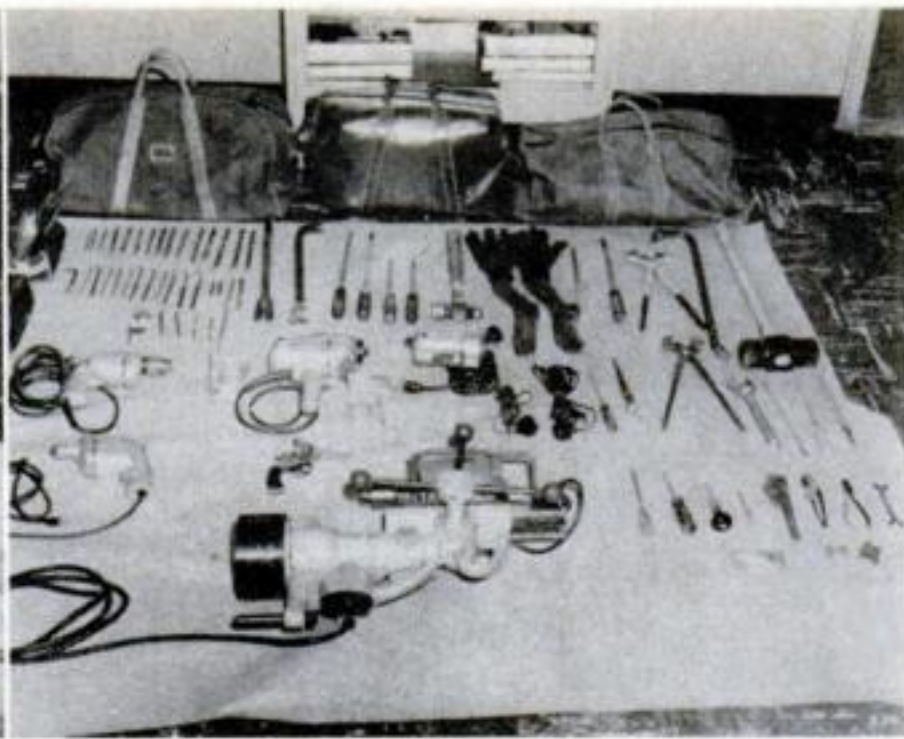
TWO-PART SAFECRACKING KIT of an expert in the business even includes a walkie-talkie radio for communicating with a lookout, and up-to-

scattering choice meats far and wide. Neighborhood dogs for blocks around had a picnic. There are cases on record of safeblowers who have been killed by their own blasts.

And working a combination with sandpaper-sensitized fingers went out with Jimmy Valentine. A lock's tumblers don't tumble for that any more.



A WOULD-BE SAFEBLOWER in Canton, Ohio, abandoned this job, probably because he was afraid to set off an overcharge of nitroglycerine. It was opened by an Army ordnance officer after nitro had been neutralized with alcohol.



date literature from safe manufacturers. The kit got its owner more than \$400,000 in loot before he was killed by police in a gun battle.

The legal burglars, teamed with the designers of safes, are in a constant battle of wits with the underworld. When, a few years ago, criminals began using improved, hotter torches, the designers sandwiched copper inserts between the safe's thick outer layers of steel. The inserts dissipated the heat from a torch so rapidly that burning through became impossible.

When the criminals began using improved drills, the designers tried case-hardened metal inserts. This seemed like the answer—until the criminals hit on diamond and carbide drills. Once again safe manufacturers were on the defensive.

Where do they stand today? It's something of a secret. Understandably, neither safemakers nor the underworld will talk about their latest developments.

Within-the-law crackers still attack some types of safes—the smaller ones—with explosives. That's because criminals do manage to open some that way. Test tools also include sledge hammers and crowbars, used to peel the tough layers from the sides of a safe. If burglars can get them off, the designer has failed. For the concrete inner liner may then yield to a drill.

Of the two dozen safemakers in this country, many use the testing facilities of the Underwriters Laboratories in Chicago in addition to their own test men.

They are making progress. Recently, in Detroit, burglars who fruitlessly attacked a safe left this message scrawled on the wall: "You've got a hard safe to crack. We'll try again!"

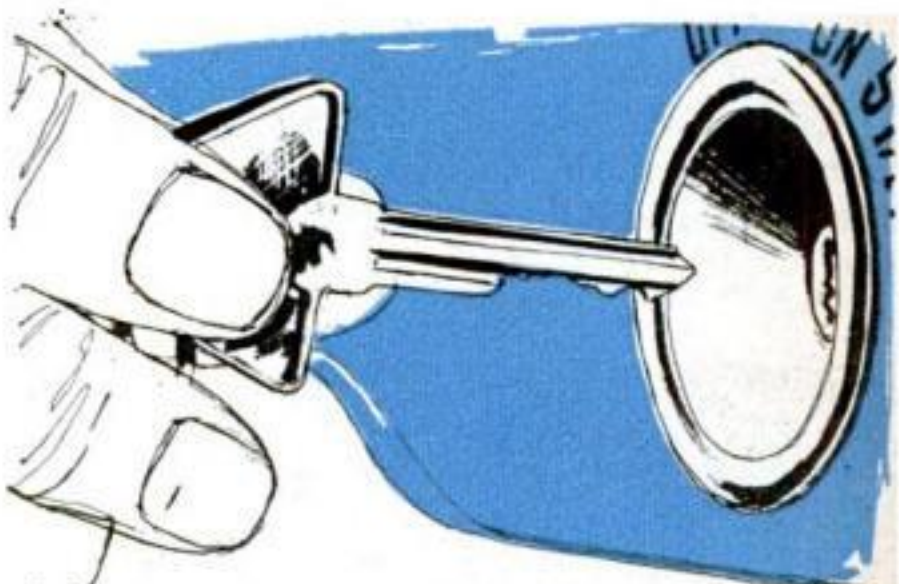
"I'd like to see them make..."



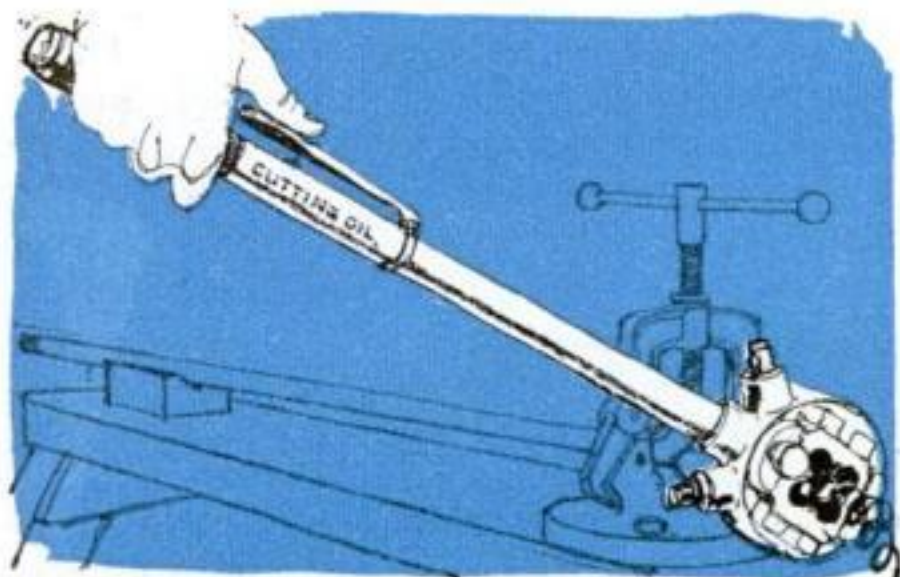
PUSHBUTTON FLOOR TRAPS at bank tellers' windows. A robber dropped into a cell beneath the floor would be held securely until police arrived.—*Dan Stallings, Van, Texas.*



PICK-THE-SPOT LP RECORDS so you could guide the needle to a particular piece of music. Why not white interval spaces between the recorded bands?—*Cy Groves, Calgary, Canada.*



A FUNNEL-SHAPED LEAD-IN for a car's ignition key. An integral part of the ignition switch, it would guide the key directly into the keyhole.—*R. D. Remy, Rochester, Ind.*



TRIGGERED PUMP OILERS in the handles of die stocks and tap wrenches, and an oil exit at the cutting point. No more stops to apply oil.—*A. R. Tanner Jr., Poughkeepsie, N.Y.*



CHILDPROOF SINK CABINETS you'd open with a pushbutton or lever on the top. This would keep toddlers from reaching harmful cleaning chemicals.—*Mrs. M. Koslover, Reading, Mass.*

Everyone has his own pet idea of a gadget that he would like to see in general use. The five ideas illustrated above were suggested by **POPULAR SCIENCE** readers. What's

yours? We will pay \$5 for each one published. Please use Government postcards only. Write name and address clearly. Contributions cannot be acknowledged or returned.



COMBINE cuts and stacks a cord of wood in 20 minutes. It's happiest in a dense stand of timber.

Here's how it works ▶

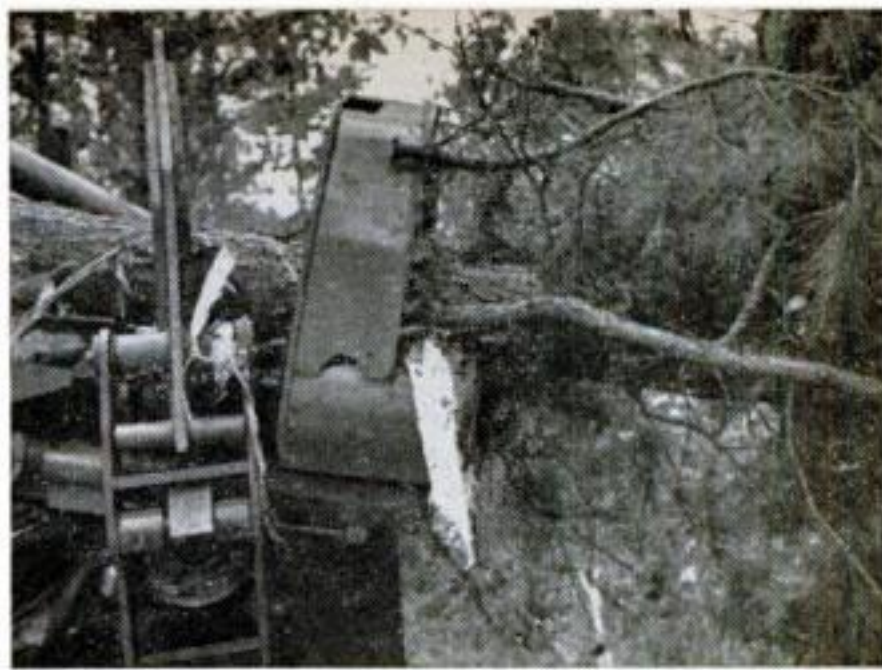
1 TRUNKS ARE CUT almost at ground level to minimize waste. These hydraulic-piston-operated scissors can shear a trunk up to 19 inches in diameter in about seven seconds.

Tree-Chopper Cuts,





2 FLEXIBLE, SHARP-EDGED DE-LIMBER gets set to lock around a tree trunk. The hydraulically operated foot-wide cutting belt can shear off limbs almost six inches in diameter.



3 SPRING-LOADING enables de-limber to get close to the trunk, compensating for the taper of the tree. A scissorlike bucking blade follows through, lopping off pulpwood lengths.

Stacks Pulpwood... and it works

four times faster than an expert chain-saw crew, with far less waste

THE combine lumbered through the forest like a monster beetle in search of a meal. It spotted its prey—a pulpwood-size tree—and wriggled toward it, its jointed, two-piece chassis flexing.

It stopped. Clawlike scissors grappled for the tree. *Snap!* They bit into the trunk. The tree shuddered. Slowly at first, then faster, the tree toppled forward, the direction of its fall controlled by the wedge action of the blade.

A steel arm lifted the victim onto a carriage that pushed the tree rearward. A sharp, foot-wide flexible steel belt wrapped around the trunk and slashed off the limbs. At the same time a bucking blade snipped 63-inch logs from the trunk and spat them out. A cradle caught the logs, bound them in cord-size bundles, and deposited them vertically.

This demonstration took place recently in Louisiana. The super-machine, a prototype developed by International Paper Company, passed all its tests in high style, indicating that the pulpwood-

4 TRUNK RIDES A CARRIAGE that pushes it 63 inches at a time. The hydraulic bucking blade cuts it into even lengths, which drop into a cradle. There they are bound and dropped.

CONTINUED



5 PICK-UP-STICKS RIG, working on principle of the human arm, picks up and loads the

7,000-pound bundles. Lifting each load requires up to 1,500 p.s.i. hydraulic pressure.

logging industry is due for some changes.

What is it? Basically the combine is a heavy-duty four-wheel-drive tractor powered by a GMC 371 diesel engine and Allison torque converter. Engineering the chassis wasn't a major problem: The vehicle had to conform to certain dimensions to comply with highway regulations; it had to be self-propelled; it had to be jointed in the middle to give it an extra-short turning radius and to keep all four wheels down on rough terrain.

Designing the cutting and stacking rig, however, was a seven-year labor for perfection. The idea was to get the most work out of the tractor with the least effort. Earlier versions of the blade felled trees at right angles to the tractor. No good. The machine would have to move around for the next stage. So the blade

was positioned to fell trees parallel to the tractor.

More snags. Then came the de-limbing problem. "That was when we really got off the ground," said designer T. N. Busch. Hoisting the whole tree on board the tractor turned out to be the tidiest solution. The de-limbing belt and traveling arm neatly stripped the tree of its limbs. The bucking blade followed through.

Stacking and tying the cut wood vertically was a final bit of ingenuity that eliminated a serious work menace: More than one lumberman slinging wire on the ground finds a snake in the woodpile.

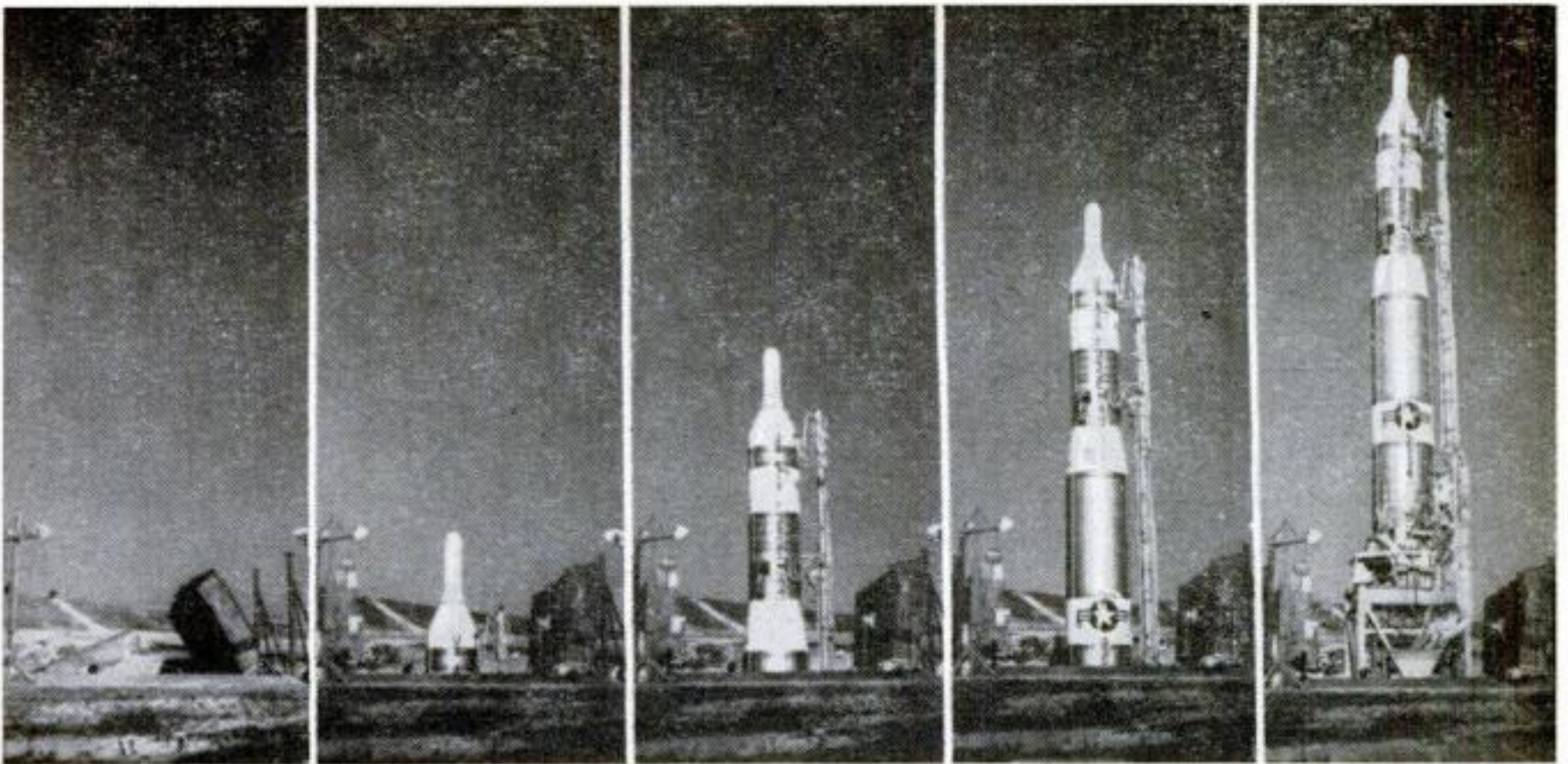
The two-man, almost-automatic combine now cuts and stacks two cords of wood an hour—four times what a pair of woodcutters can do.—*Alex Markovich.*



What is this?

Can you identify the pattern of objects in this picture? Check your answer below

ANSWER: The objects are people at the Japanese Gymnastic College in Tokyo. The athletes—20,000 strong—came from all over Japan to attend the meeting.



Trap door opens . . . nose pokes out . . . rises higher . . . and higher . . . ready for launch.

Big bird leaves its underground nest

This sequence of photos, taken at Vandenberg Air Force Base in California, shows the raising of a Titan I missile from its underground steel-and-concrete silo in a practice launching drill. It's

automatic. As the 200-ton doors open, the 97-foot, 110-ton intercontinental ballistic missile is raised on an elevator to the surface where it can be fired. Operation is completed in minutes.



Wireless tape recorder

This supermarket clerk is taking inventory by speaking into a radio microphone. The rest of his remote-control recording system is in the store's office.

The unit has a half-mile range and operates on citizens-band channels, making it handy for inspection-reporting, training, and police work. American Geloso Electronics, New York, developed the system, sells it with transmitter and recorder for \$1,000.



Submarine-launched landing craft

The Marines have a new landing craft. Their smallest and lightest, it can be launched from a submarine. The rubber boat is placed on the deck of a surfaced sub, inflated, and manned by seven Marines. Then the sub dives, and the Marines paddle off on their shore mission. The process is reversed for getting them back on the sub again.

How a Self-Winding Watch Works

TODAY'S sleek self-winding watch dates back to 1752, when an instrument textbook described a pedometer that wound a watch as one walked.

In the common pedometer used to measure walking distances, a pivoted weight is so balanced by a hairspring that each step of the walker swings it down momentarily. A spring finger advances a fine-toothed count wheel as the weight swings back; a click or detent holds the wheel during the downswing.

A Swiss watchmaker applied this action to a watch around 1800, and during the next 20-odd years many self-winders

were made. In 1893, the Swiss mass-produced one with a reserve-power indicator. With the wrist watch, in which arm movement wound the spring, self-winders became practical for everyone.

In earlier actions, the weight hit springs at each end of its swing and wound only when turning in one direction. In modern types, the weight can turn completely around, and winds going either way—so restoring mainspring energy more quickly and reliably. The action at right and below is the Bidynator, made by Felsa in Switzerland and used in some Bulova, Benrus, and Gruen watches.

Weight winds spring through gear train

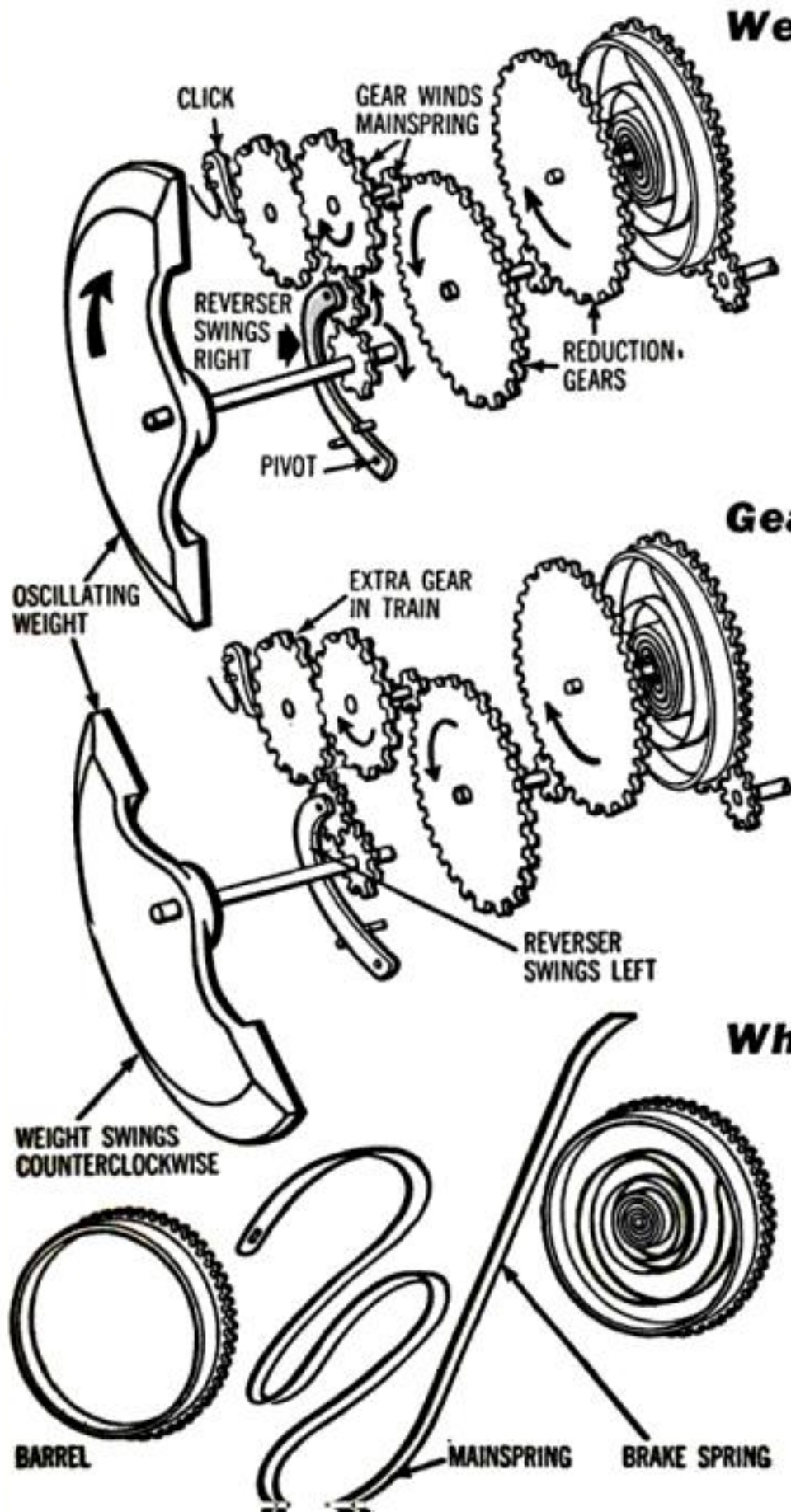
FREE TO TURN AROUND completely, the oscillating weight swings one way or the other as the wearer moves his arm. A pinion on the weight shaft meshes with a gear turning on a curved arm. Pivoted at its other end, the arm is held toward the right, and its gear engaged with the right-hand one of the pair above it, by clockwise rotation of the weight shaft. This rotation, through the gear train, turns the mainspring shaft clockwise, so winding the watch.

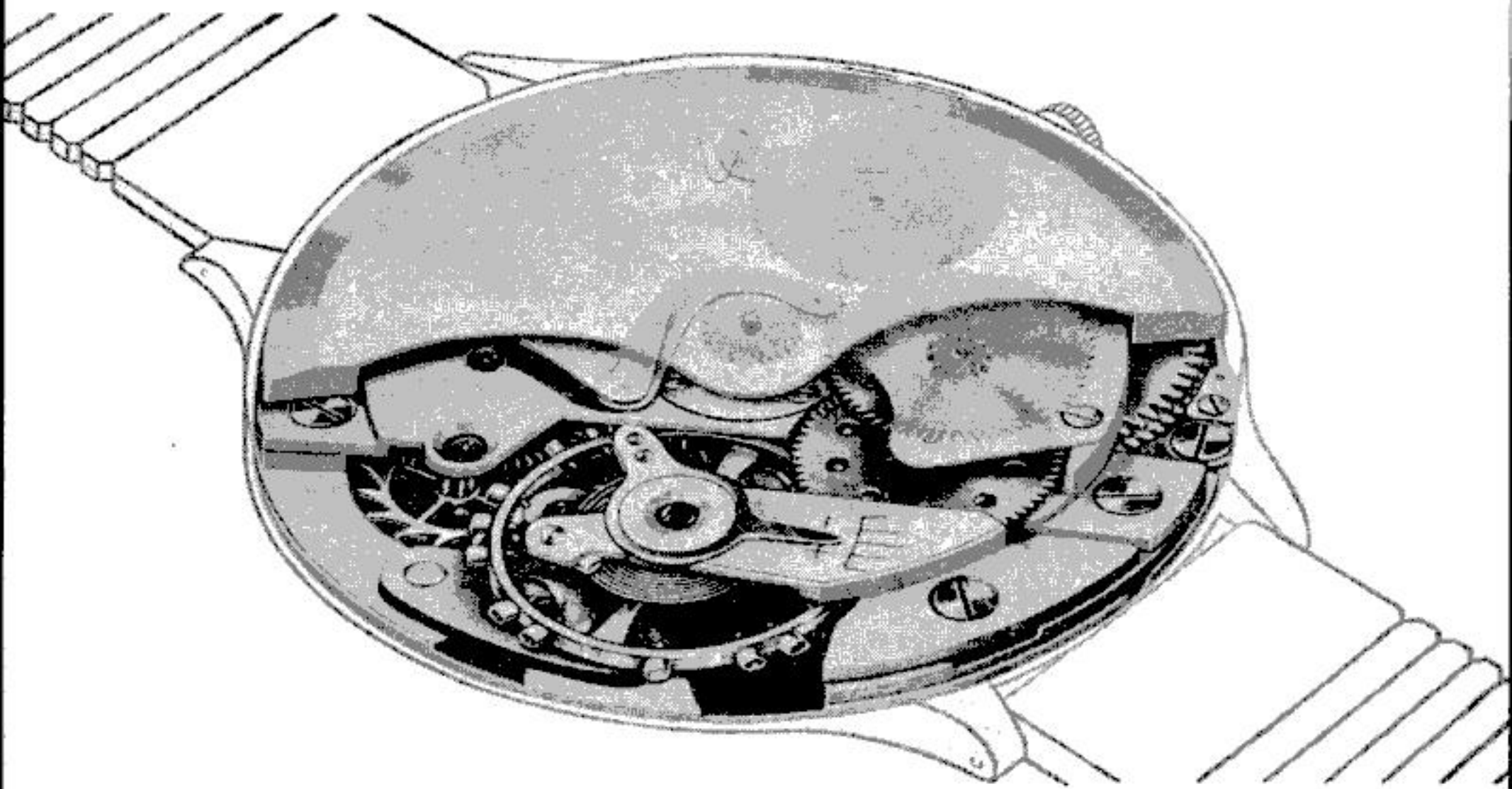
Gears shift as weight swings back

WHEN THE WEIGHT STOPS, a click on the left-hand wheel holds the winding train. As the weight swings the other way, the click prevents rotation, so the pinion rolls the reverser off the right-hand gear into mesh with the left-hand one. Now it turns this left-hand gear in the direction permitted by the click. Driving through an extra gear, counterclockwise rotation of the weight turns the mainspring shaft clockwise, the same way as before, and so again winds the watch despite its reversed swing.

Why overwinding can't break springs

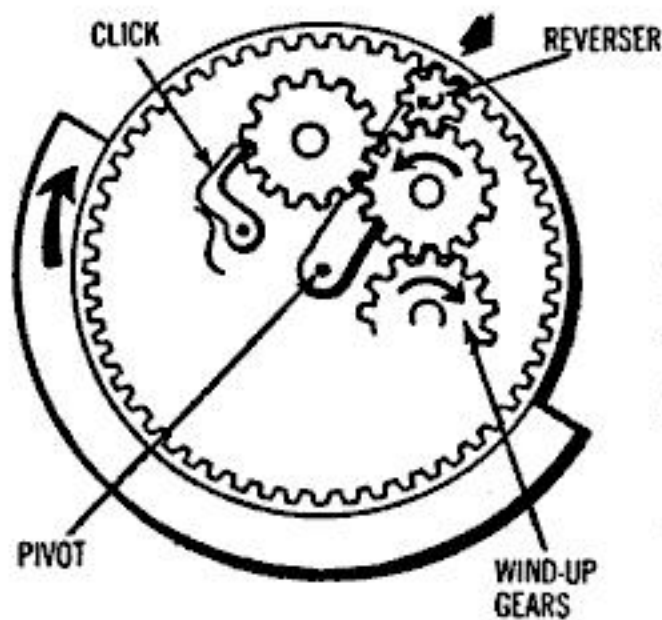
COILED UP in a shallow barrel and wound by the shaft on which it is fixed, the mainspring has a short, stiffer, brake spring fastened to its outer end. This presses against the smooth inner wall of the barrel. Acting like a friction clutch, it drives the barrel and the watch movement. But when almost fully wound, the mainspring's constricting coil pulls the brake spring off the barrel wall. It then slips around until the mainspring unwinds enough to let the brake spring again apply driving friction.





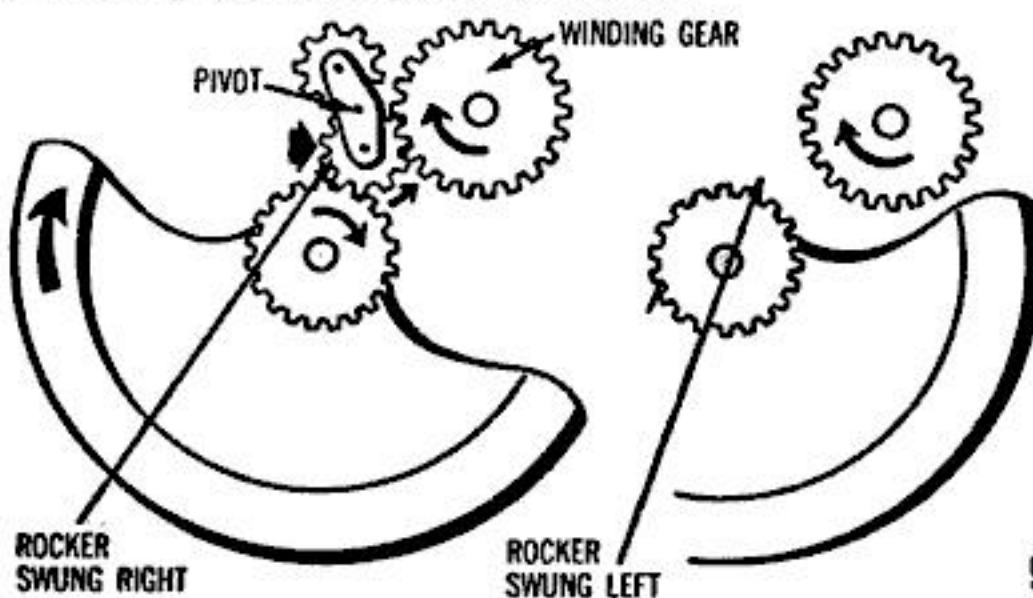
Three other kinds of self-winding action and how they work

ULTRA-THIN SELF-WINDERS have oscillating weights (or rotors) of half the size mounted within the movement. The one at right also has two meshed winding gears with a reverser between them and the rotor gear. But this reverser has no pivot; it lies free in a shallow recess. Under each gear is a disk of its pitch diameter; when two disks touch, their gear teeth are perfectly meshed. As the rotor turns clockwise, it rolls the reverser into mesh with the right-hand winding gear. On counterclockwise rotation, the reverser slides into mesh with the left-hand one, again driving the wind-up train and mainspring shaft in the right direction.



SHAFTLESS ROTOR running on a circle of ball bearings energizes the action at left. The rotor's internal ring gear meshes with a reverser gear on a pivoted arm. Turning clockwise, the rotor swings the reverser into mesh with the right-hand winding gear. The reduction gear below revolves clockwise, a two-way click on the left-hand winding gear holding the train as the rotor stops. Turning counterclockwise, the rotor gear swings the reverser off the right-hand gear to the left-hand one, which reverses rotation to drive the reduction gear clockwise, winding the mainspring as before.

TWO ROCKER GEARS, in mesh on a center-pivoted arm, alternate to drive the action at right. Clockwise rotor motion swings the lower alternating gear into mesh with winding gear, which turns clockwise. When the rotor turns counterclockwise (far right) the rocker arm tilts to the left, and the upper alternating gear engages the winding gear. As there is now an extra gear in the train, this rotation drives the winding gear clockwise again.



The Tough and Ticklish Job of Air Refueling

With a trapeze artist's split-second timing, the B-52 hooks onto its tanker in mid-air and gulps 15 tons of fuel

By Capt. T. W. Sherman Jr.

AS OUR B-52 turned high over Scranton, my interphone crackled, "We're coming up on our tanker. Are you ready for the refueling?"

Thus began my first try at air refueling, one of the most demanding jobs in flying today. Any SAC bomber pilot will tell you that he sweats out air refueling more than anything else. It takes all the skill and guts he's got to wrestle a big bomber in behind a tanker where a slip can mean flaming disaster.

Planes have collided, refueling booms have been ripped off tankers, and men have been killed refueling. It gets so hairy that even the tanker crews get shook at times. A veteran tanker pilot told me, "You'd never get me back there to watch a refueling—it scares the hell out of me!"

"Roger, I'm ready," I answered now. I had watched other pilots refuel so I knew how it was done. Of course, doing it myself might be a different story, and an instructor, Capt. Bill Penzien, was on hand to keep me out of trouble.

Our tanker, a KC-135 jet, is orbiting Montpelier, Vt., with 30,000 pounds of fuel for us. Capt. John Busbee, our radar operator, reports over interphone, "Pilot from radar, I've got a beacon at 180 miles."

"Roger, check the code."

The tanker's beacon transmitter puts a coded series of blips on Busbee's radar scope. He identifies the tanker by its code.

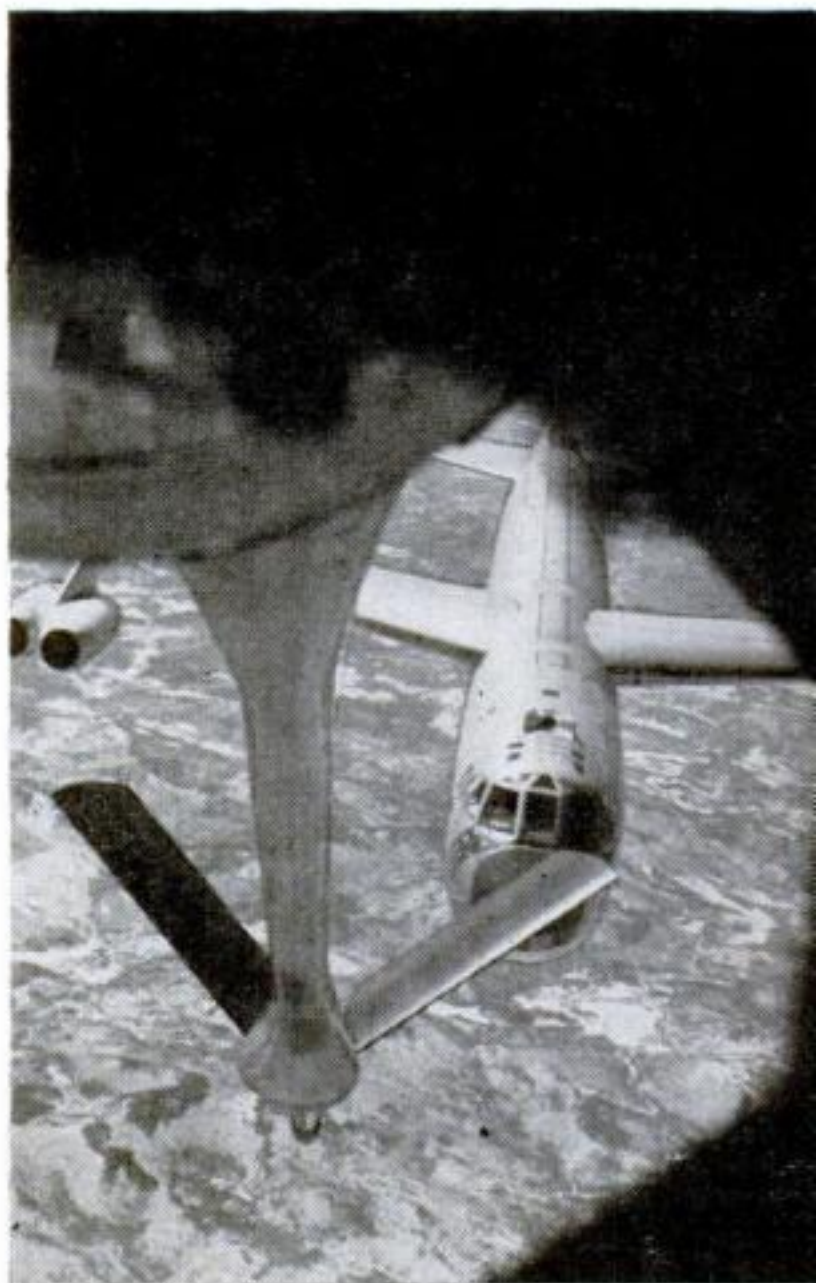
"It's ours; the code checks."

In a few minutes we're 80 miles from the tanker and we descend to his altitude. Busbee and his radar keep us on course and posted on the distance to the tanker.

As I bank the plane to intercept the tanker, I'm aware of the heaviness in the controls that is characteristic of this tremendous Boeing B-52. You



Here's what the operation looks like from outside



And here's a tanker's eye-view



BOOM EXTENDED, a Strategic Air Command KC-135 tanker prepares to receive a B-52 jet bomber for a refueling hookup. A miscalculation can cause the two planes to collide, or the boom

to break. Tanker totes fuel for transfer in both wings and fuselage. Nominal 15-ton transfer would run a car—if the stuff would burn in an automobile engine—for 75,000 miles.

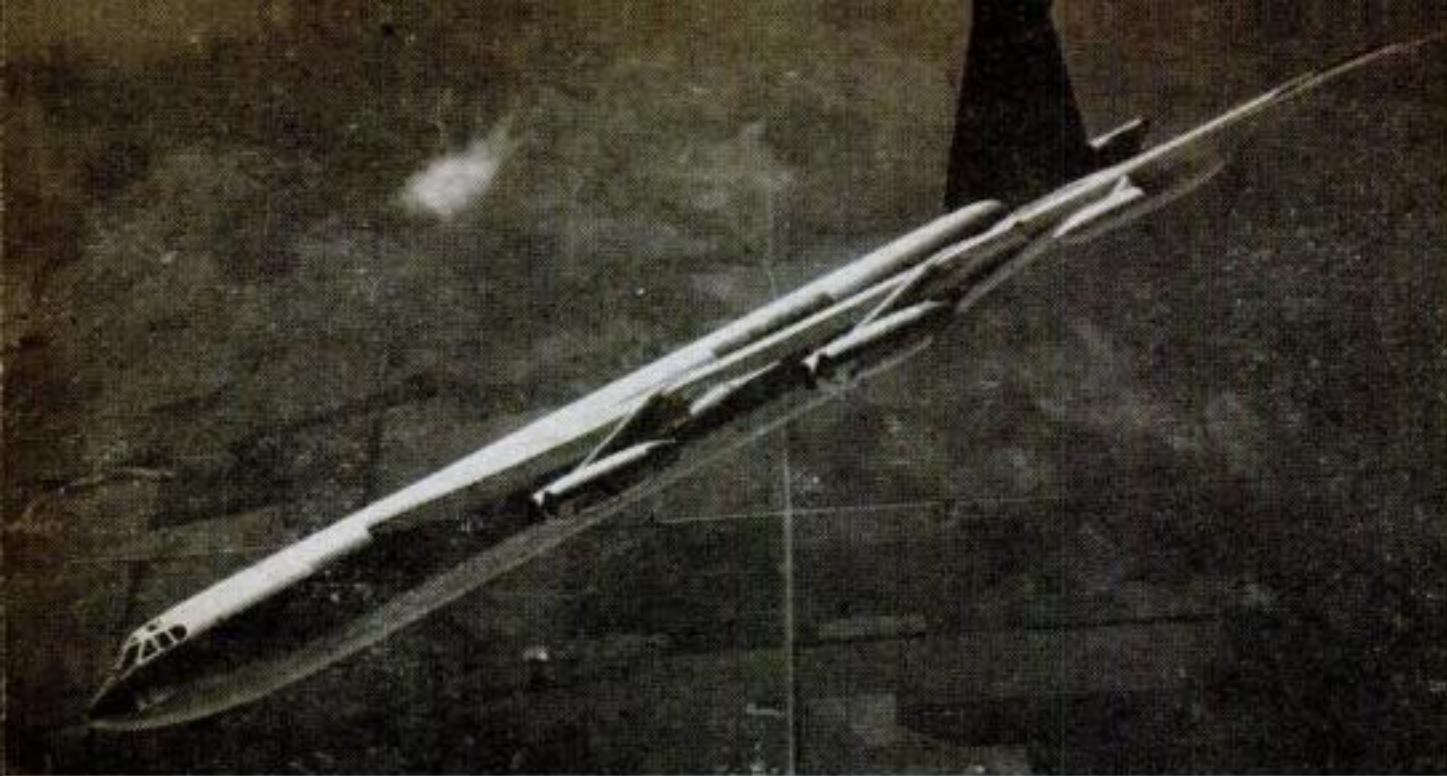


MAKING THE HOOKUP. Photos show (left) bomber gliding toward "envelope" area. Tanker's boom operator, lying prone, "flies" boom by its wing-like projections to fuel inlet atop



bomber's fuselage, six feet behind windshield. Semiconical receiver guides boom's nozzle in to a point where hydraulic levers seize it. Tension causes levers to release the nozzle.

CONTINUED



BOEING B-52G is the latest of SAC's jet bombers. With full fuel load, it weighs 244 tons, four times as much as a jet airliner. Plane has flown 10,000 miles without refueling. With refueling, its range is limited only by physical endurance of crew. SAC completes 140,000 fueling hook-ups a year—more than one each three minutes, day and night.

definitely know there's a lot of airplane behind you. One pilot said it was like "sitting in your living room, flying your house." Its handling won't be affected much by the 15 tons of fuel that we're going to take on. It starts getting touchy at around 400,000 pounds and today we weigh only 300,000.

I've throttled back so that I'm indicating 250 knots. The tanker's boom operator has the boom down and radios, "Tanker ready for contact."

I answer, "Receiver ready."

Pulling in a little closer, I see the Pilot Director Lights. These are on a panel on the bottom of the tanker, just forward of the wing. Two rows of red and green lights controlled by the boom tell me to fly up or down, fore or aft.

Here's my problem: To make contact with the tanker, I have to maneuver the nose of my 150 tons of airplane into a narrowly limited area immediately below and behind the tanker. This area, called the "envelope," measures only 12 feet long, 14 feet high, and 21 feet wide. Try it—whizzing along at 300 miles an hour.

The envelope has walls. They're just invisible. If I don't keep the bomber within these walls, the tanker's boom will automatically disconnect to keep it from getting damaged.

Keeping the 52's nose in the envelope wouldn't be simple under any circumstances, but there's an added complication. The tanker's slipstream creates a strong downdraft in the area of contact. So I have to trim into a nose-high attitude. This is no great problem, except that if I get just a little too far forward, the 52 will go out of the downdraft and will zoom up. Unless I shove the control column forward and pull back the throt-

tles fast, we'll collide. In a perfectly normal hookup, tanker and bomber frequently come within 25 feet of each other during refueling.

Moving into the contact position, I aim for the end of the boom and slowly pull forward. The boom operator raises the boom to clear my windshield. The turbulence and downdraft are increasing and the tanker seems to be hopping around like a pea in a whistle. The boom operator talks me in: "Forward ten, up four—forward five, up two—stand by for contact—contact tanker."

But I'm going too fast. The boomer warns me, "Back two—back four—disconnect."

Clenching the wheel tighter, I force my plane back into contact. Twice I had sailed right through the contact position, but moving so fast the boomer didn't have a chance to stick the boom in. I'm dripping sweat. My breath is rasping against my oxygen mask.

Now I'm dropping too far back in the envelope. At the first sign of slipping back, I ease the throttles forward a little, then a little more, then a lot, but it's too late. The boomer directs, "Forward three—forward five—you're approaching the outer limit—disconnect."

"Here, let me show you," Penzien says patiently.

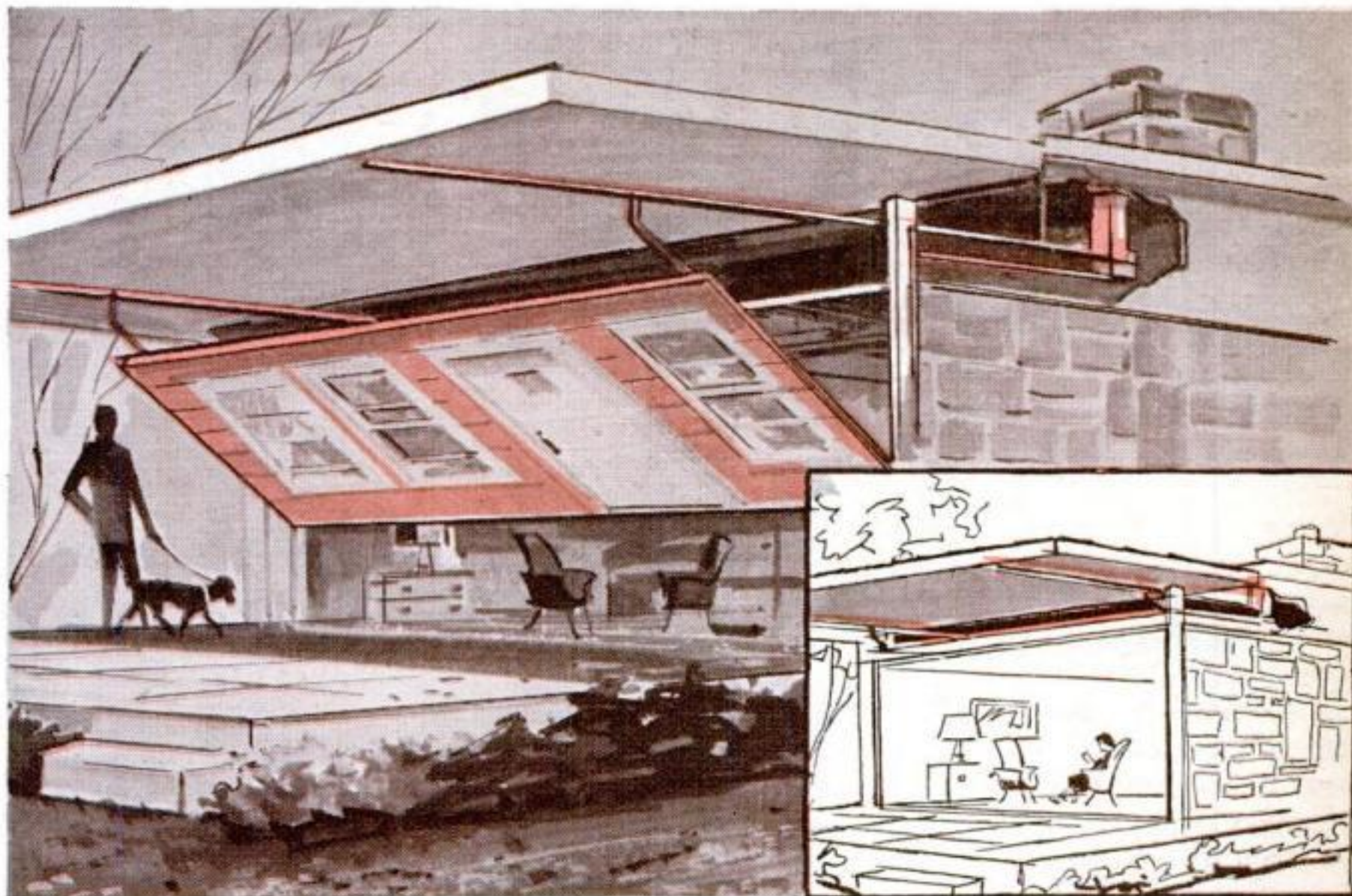
He takes the ship and jockeys it in. "I'll show you the limits," he says. He slides from side to side, just to the limits, but not quite far enough to disconnect. Then he touches the upper, lower, fore, and aft limits. It's as if the envelope had walls that we couldn't penetrate. He makes it look easy.

"Okay," he says. "Now try it again."

[Continued on page 220]

New Ideas from the Inventors

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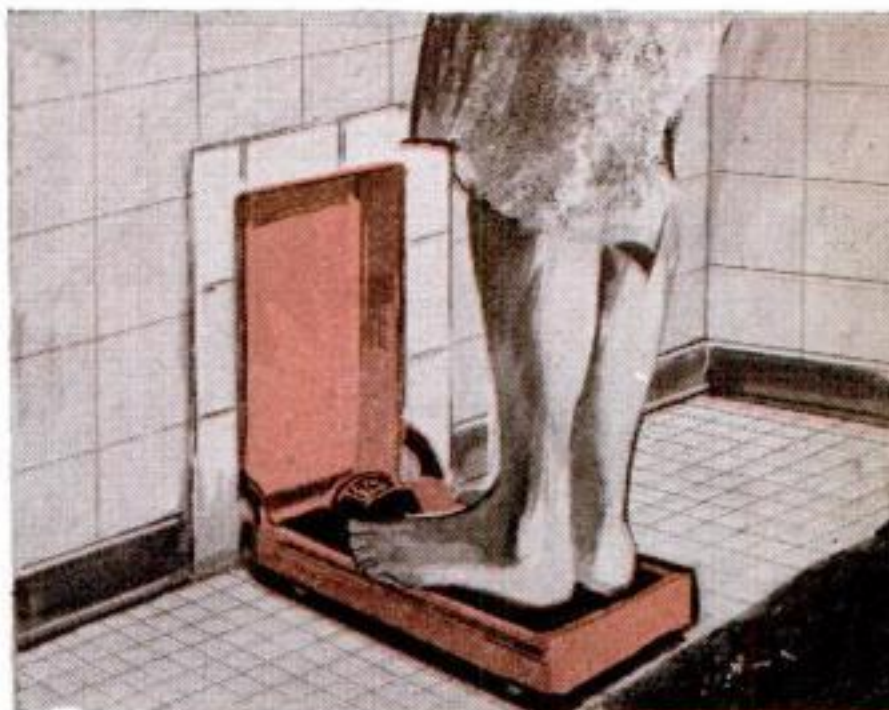
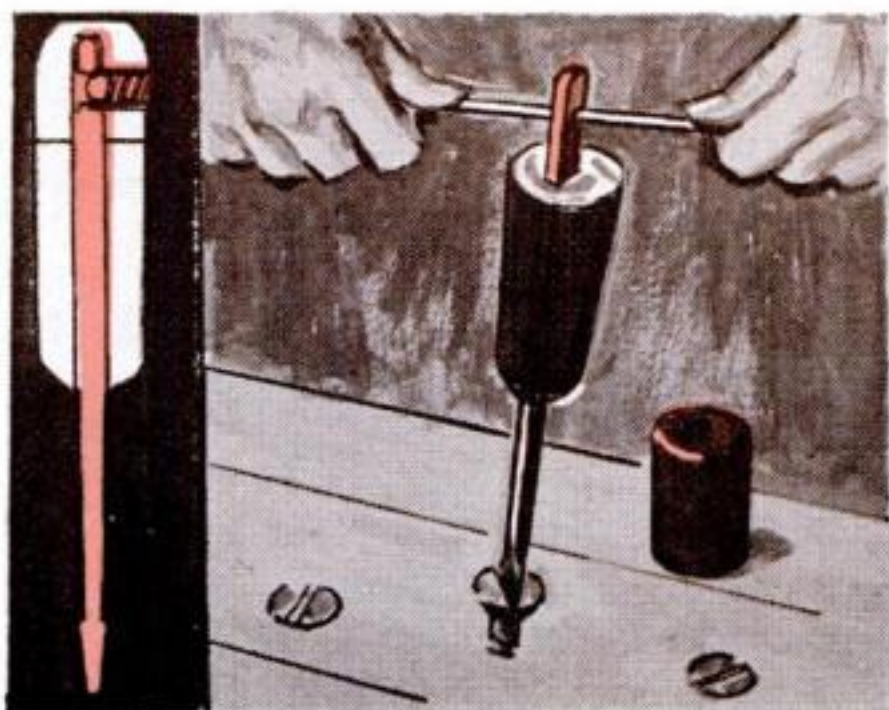


Swing-Up Wall Broadens View. Both the look and outlook of your house could change with the weather if it had a disappearing wall like this. A motor would

lift this recently patented, rail-mounted wall, then pull it back under the roof overhang. Pictures and ornaments on the wall would travel undisturbed.

Driver Shank Takes Extra Twist. If tightening—or loosening—a screw needed more torque than you could apply in the usual way, you'd snap the spring-held cap off the end of this driver handle. You could then turn the squared shank with a wrench or, as shown, by inserting a rod.

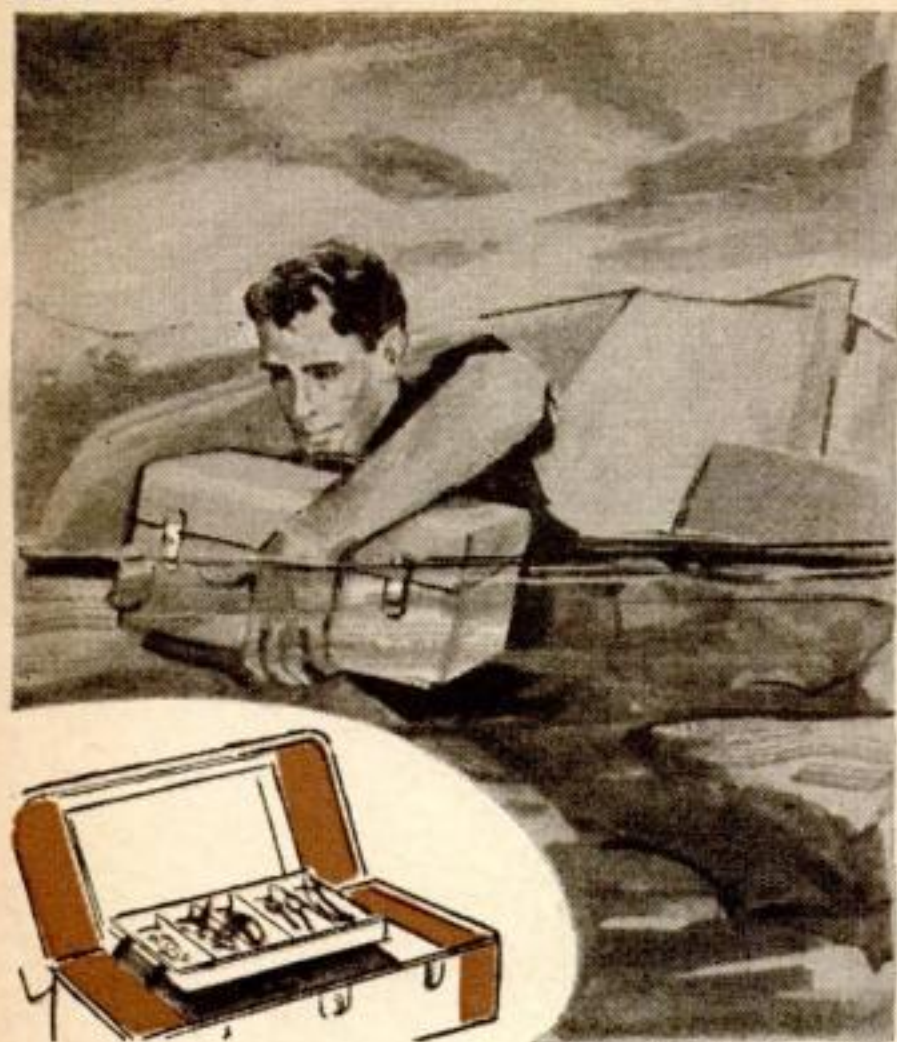
Scale Folds Into Bathroom Wall. Built into the base of a wall, this let-down bathroom scale would be handier to use than most, yet wouldn't take up any floor space. The bottom of the scale and the edges of the recessed frame could be tiled or masked to match any wall.



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101

More Inventors' Ideas



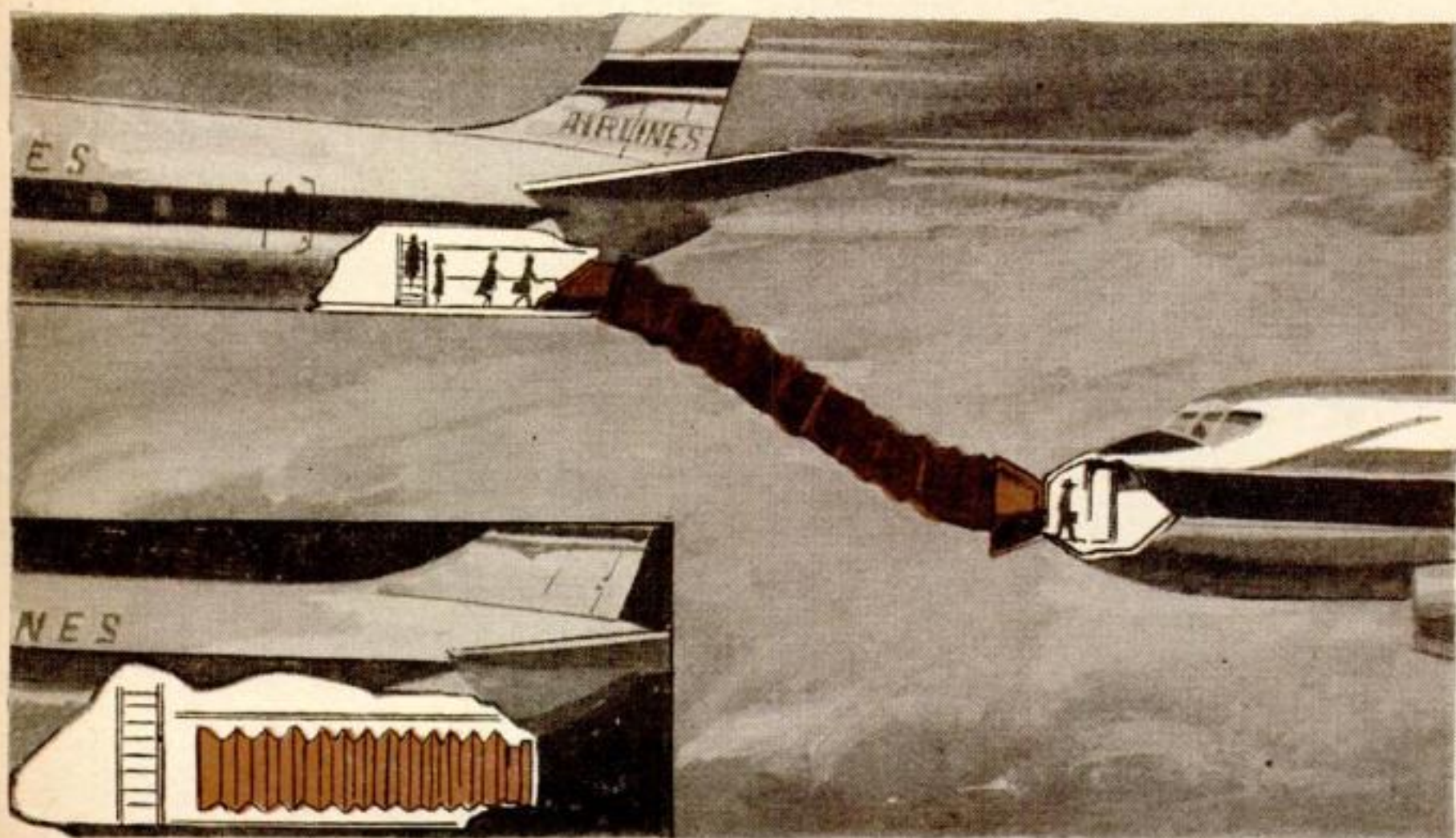
Tackle Box Doubles as Float. Airtight double walls on this tackle box might protect you as well as its contents. If the box tipped out of a boat, it would right itself, stay afloat so you could find it. If you went over, too, you could use the buoyant box as a life preserver.



Vacuum Cleaner Wheels Itself. A woman's work may never be done, but it might be made easier by this vacuum cleaner. Instead of pushing or pulling it over a rug, a housewife would just rock the handle gently. Drive wheels, belted to the motor, would do the rest.

Corridor Links Planes in Flight. With airliners fitted to carry—and receive—this extensible, people-sized tube, passengers could change planes safely if a pilot, say,

anticipated danger in landing. Or it could speed air travel by allowing passengers to make scheduled changes from plane to plane in mid-air.





Sheet Frame Speeds Bedmaking. You could make a bed without walking around it—or pulling it out from the wall—if it had this hinged, mattress-fitting frame. To fix the far side, you'd lift the frame, tuck sheets and blankets under clips, then flop it back in place.

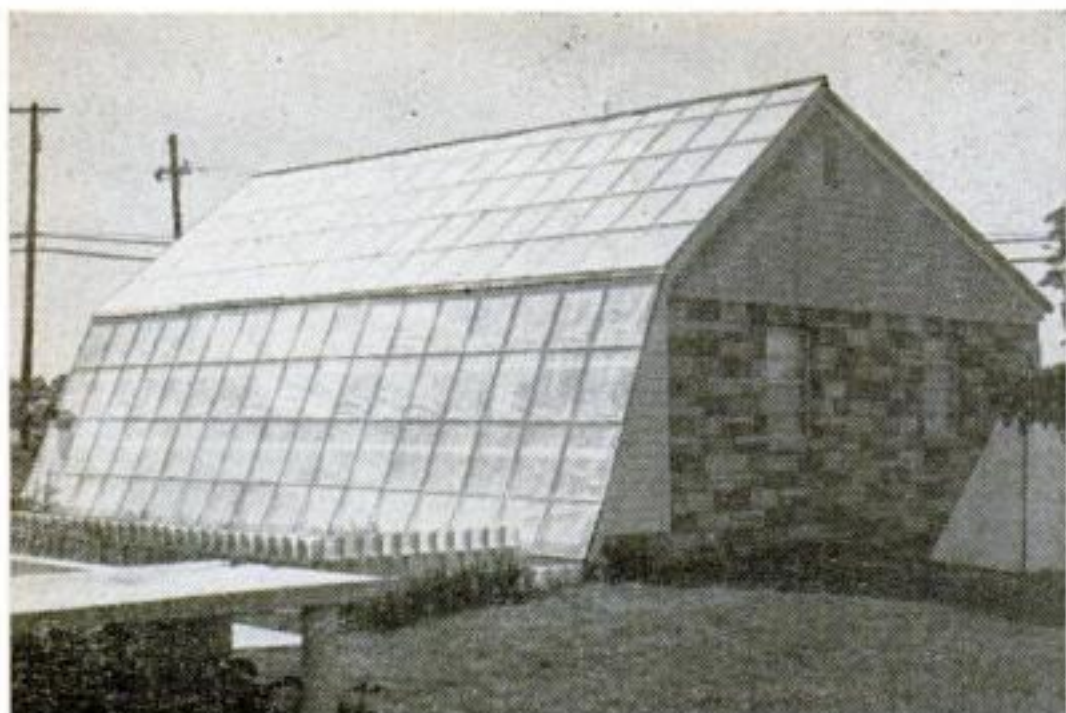
Visor Holder Unfolds Maps. You wouldn't have to wrestle with road maps on the way if you arranged them, in advance, in this visor-mounted, transparent-plastic holder. Made of precreased plastic sheets, it could be unfolded or turned to display any part. It would quickly repleat itself along the crease lines, so you could fold it up under the visor.



Propless Pump Drives Outboard. Instead of pushing water with a submerged screw propeller, this outboard unit would use a centrifugal pump linked directly to the engine. Thrust would be generated by water drawn through an inlet tube and then jetted through a rear-facing outlet.

The following patents have been issued on these inventions: Swing-up wall—No. 2,941,794 to N. Bel Geddes, NYC; Screw-driver—No. 2,825,374 to A. Reid, Galconda, Nev.; Scale—No. D 183,069 to W. Spear, Cincinnati; Tackle box—No. 2,811,276 to H. Ray, Mobile, Ala.; Vacuum cleaner—No. 2,950,772 to C. and F. Dostal, Great Neck, N.Y.; Plane corridor—No. 2,942,816 to P. Dostie, Quebec, Canada; Bedmaker—No. 2,947,008 to E. Wild, Zurich, Switzerland; Map rack—No. 2,825,988 to H. O'Reilly, NYC; Outboard—No. 2,943,593 to K. Megert Jr., and J. Line, Lubbock, Tex.

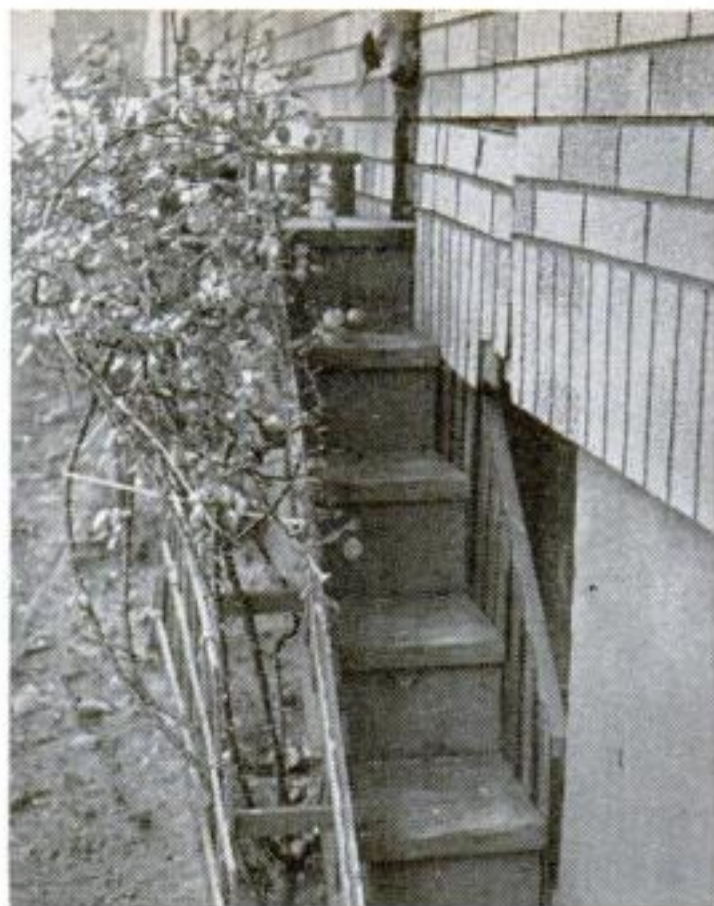
Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D.C., at 25 cents each; Design (D) patents are 10 cents. To write to an inventor, if the address given above is insufficient, you may address him (by name and patent number) in care of the Commissioner of Patents.



Lets the sun heat his house

The southwest roof and side of this Washington, D. C., home is a heat trap built of insulation material, black corrugated sheet metal, transparent plastic, and glass. Water, circulated to a collector at top, runs down into a heat-storage tank that occupies a third of the basement and is large enough to retain its heat during a 10-day cloudy period. Night air cools the water in summer.

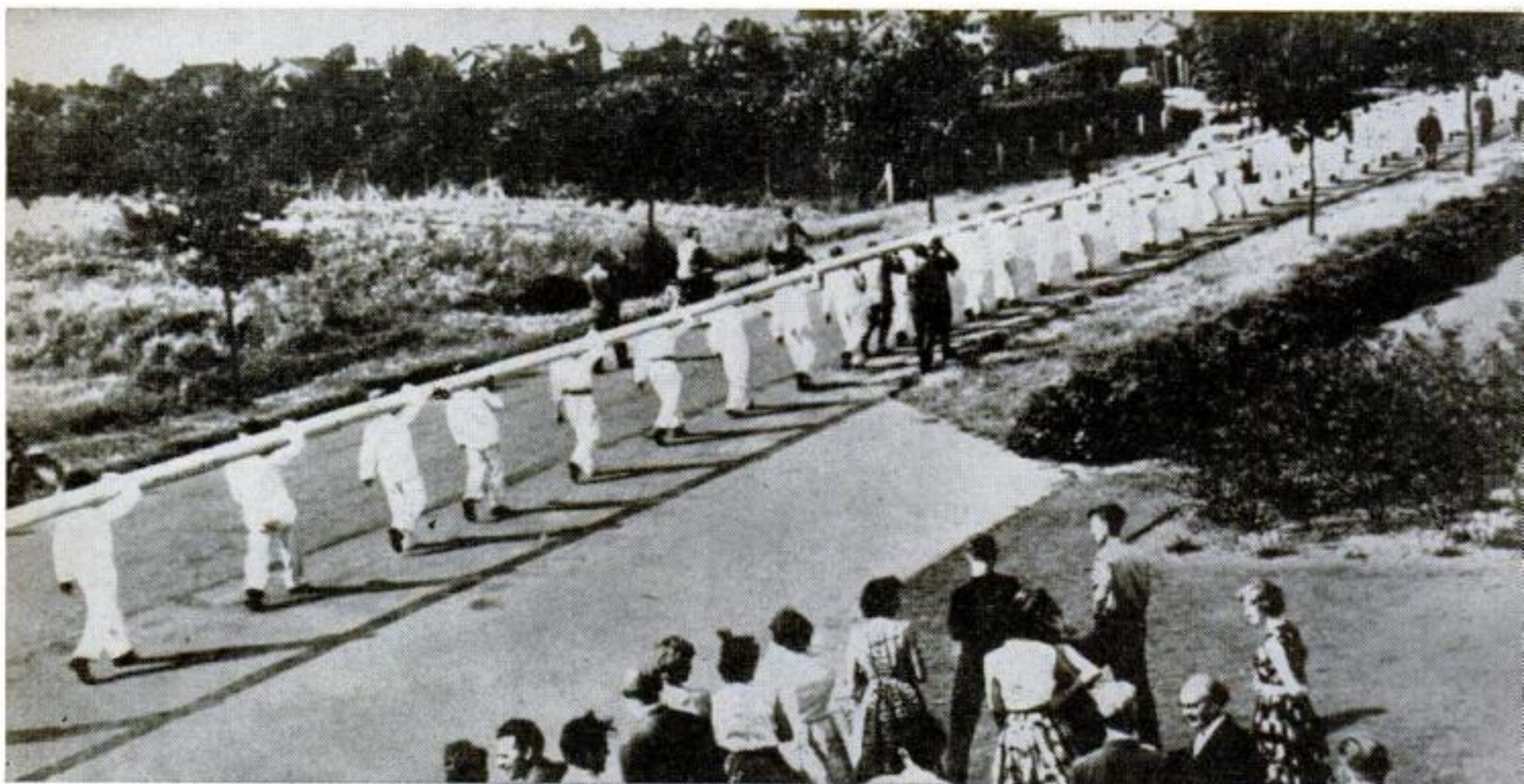
Harry E. Thomason, a patent adviser in the U. S. Signal Corps, designed and installed the heating-cooling system for \$2,500. He figures his winter's fuel bill for supplemental heat at \$4.65.



Private entrance

These stairs were built for a dog. They lead from a Brooklyn, N. Y., back yard to a dachshund-height door and the kitchen of his master, William Brickman.

Fritz, who peers around a corner above, has an eye peeled for cats and other trespassers.

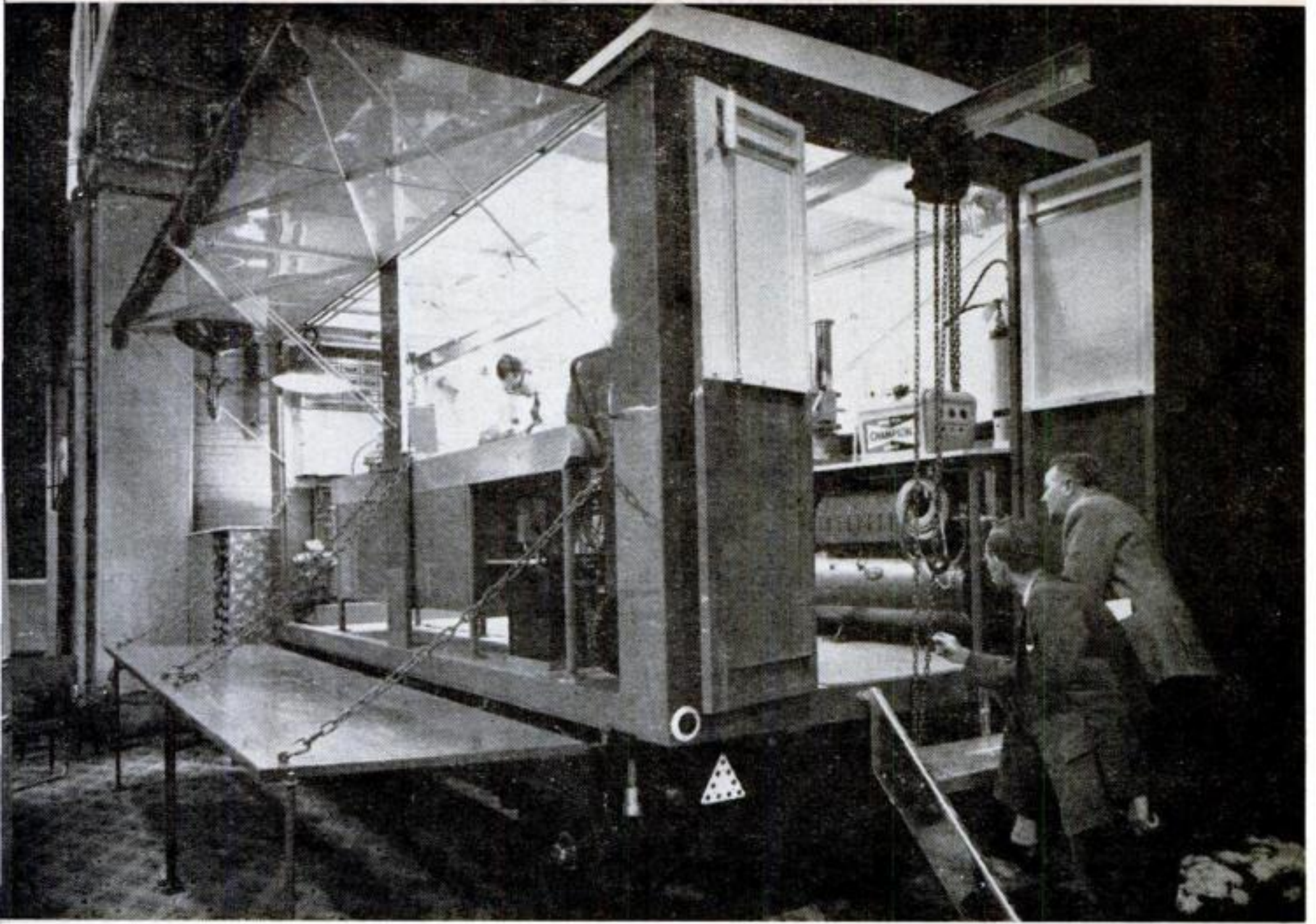


Parade of workmen transport record-length pipe

This 350-foot plastic pipe is hand-toted by 55 men to the railroad freight yards in Hardenberg, Holland, for loading on nine flatcars that took it 150 miles to Rotterdam. There the pipe will carry off salt water brought up with oil from

wells. It had to be in one piece to avoid leakage in surrounding farm land.

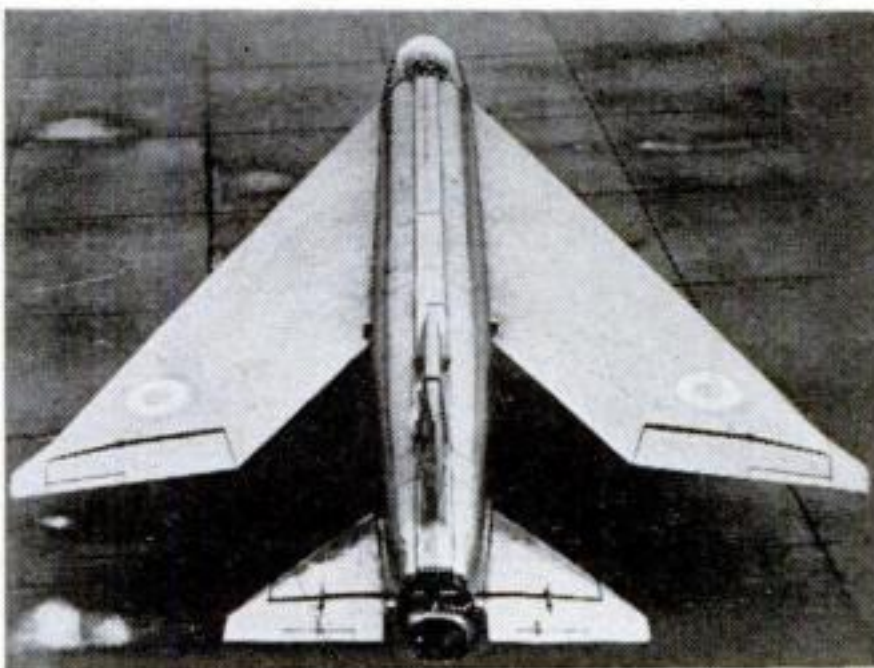
Before the long pipe was finished, it stretched through a hole knocked in the factory wall, out of the yard, over a hen run, and into a farmer's barley field.



Repair shop travels over the road

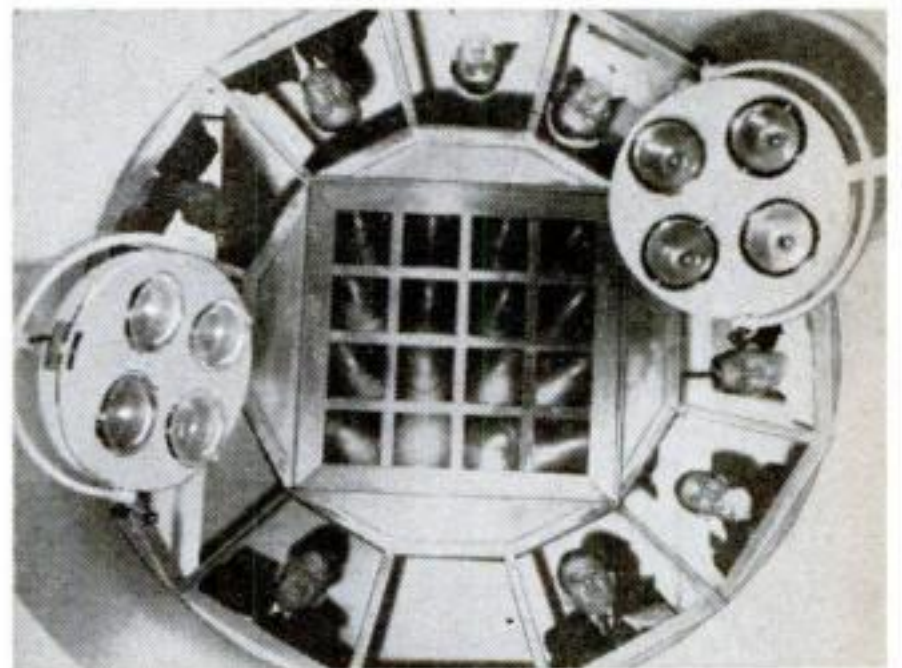
This mobile workshop houses generator, air compressor, lathe, drill, grinder, cutting and welding equipment, overhead hoisting beam, and battery charger. It's

made in Britain for the armed forces of Ghana, Nigeria, Ceylon, Malaya, and Sudan. It can be supplied as a trailer, as above, or mounted on a truck chassis.



Most sweptback wing

This British Short SB-5 jet has adjustable wings. It set a new record when it flew with them swept back at an angle of 69 degrees, as shown here. This is a greater sweepback than that of any other plane now known to be in the air.

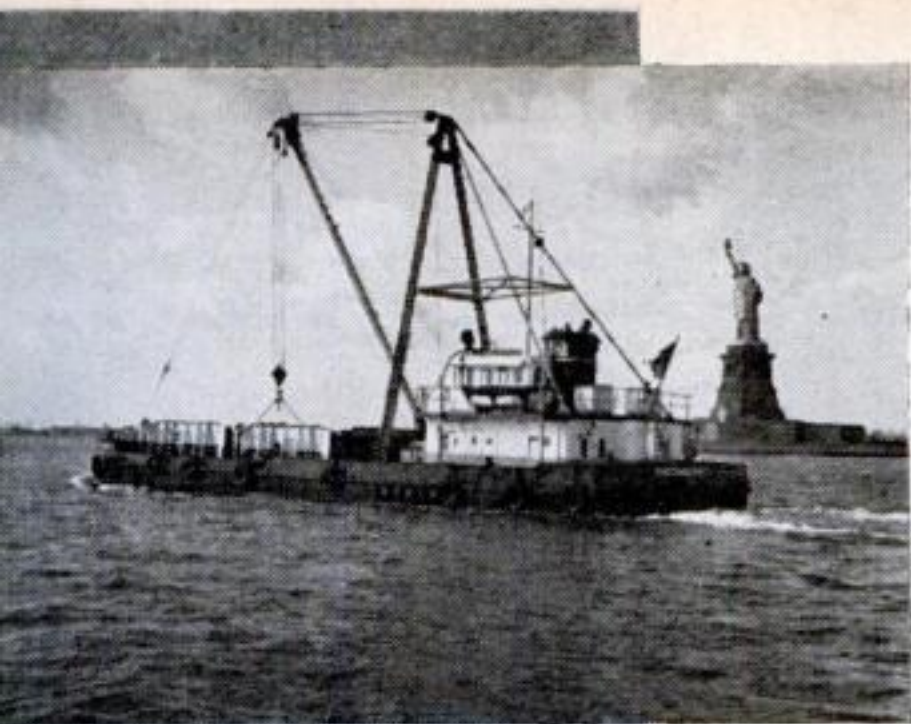


Operation eye-view

An observation dome above the operating room in a new research annex of Chicago's Presbyterian-St. Luke's Hospital lets doctors and nurses watch interesting operations. Some of the hanging floodlights are adjustable for better vision.



DRIFTMASTER, a floating carpet sweeper, bears down on a streak of drift in New York Harbor. Nets stretched between the twin hulls will gulp the seagoing debris. The Driftmaster can collect up to 56 tons of debris each day. Harbor drift can sink small craft and cripple giant liners.



They Bait Their Nets for Junk

Anything that floats can—and usually does—find its way into the steel-trap nets of the Driftmaster

By Richard Petrow PS PHOTOS BY W. W. MORRIS

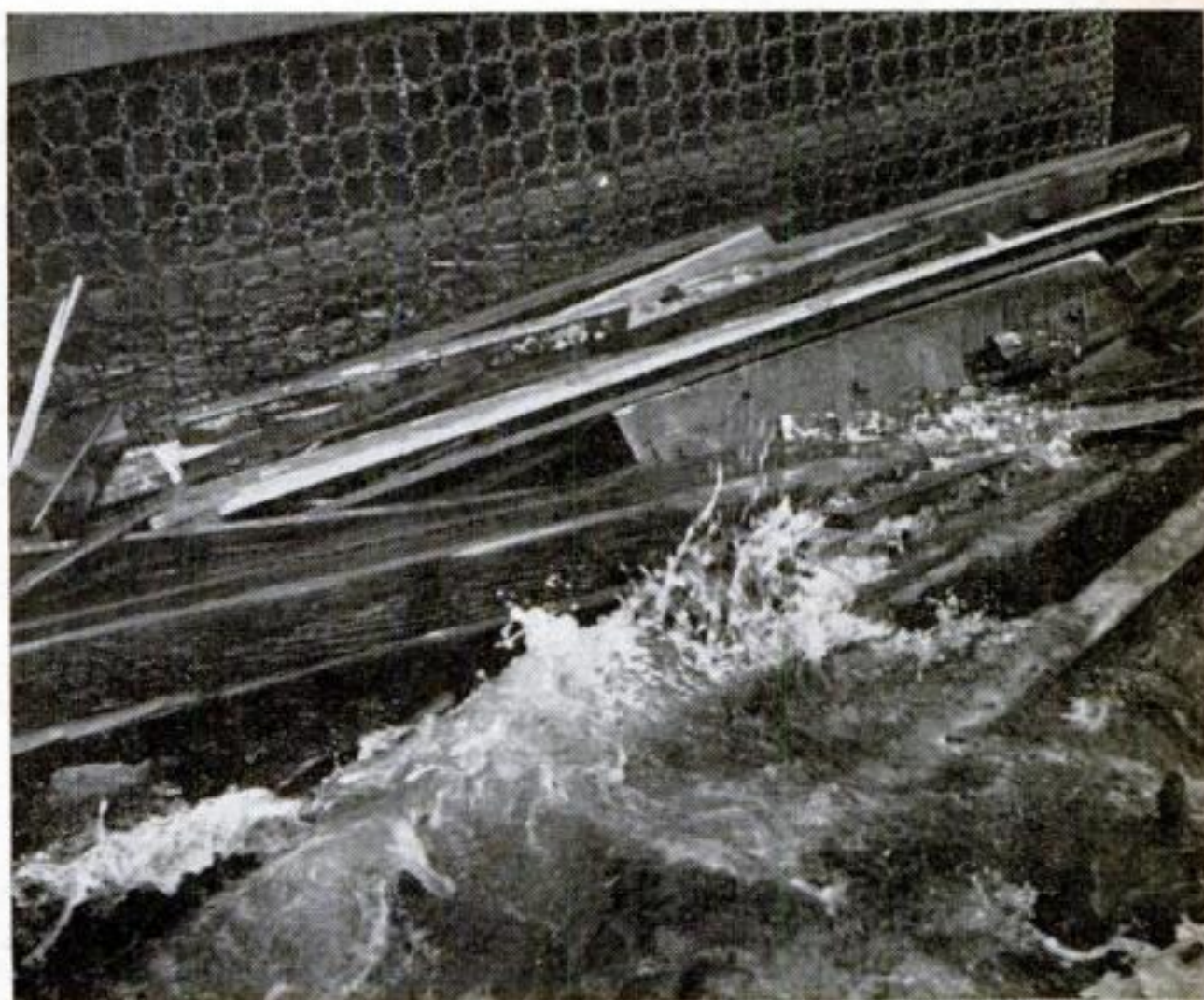
ARIDE aboard the Driftmaster is a nautical experience you don't soon forget.

The 100-foot, twin-screw, diesel-powered catamaran operated by the U.S. Army Corps of Engineers is the only vessel of her kind in the world. Her mission is unusual: to keep the world's busiest harbor clean of dangerous debris. Like a fussy housewife, the Driftmaster roams New York's harbor searching for it.

One bleak winter day I rode the Driftmaster with Bill Morris, chief photographer for POPULAR SCIENCE. It was a day the craft almost choked hauling aboard a piece of flotsam so big it could have stove in the hull of any vessel afloat.

It was cold and foggy when the Driftmaster poked her bow alongside a pier at the foot of Manhattan to pick us up.

"You're in luck," said Chief Bosun Edward Barsley. "The



NAUTICAL SPLINTERS are battered by waves after being caught in nets. Vessel has two steel-chain nets, 18 feet wide, 40 feet long.

CONTINUED

107



DEADLY PIECE of flotsam is brought alongside. This drift, part of an old pier, could stave in the hull of any vessel afloat.



DECK BOOM lifts drift and swings it over deck as crewman

tide's ebbing. We should pick up a lot of drift."

The Driftmaster's twin hulls have no structural members between them. Water can rush through the hull tunnel, passing under the vessel from bow to stern. And so can anything that floats. To trap de-

bris, the Driftmaster stretches steel-chain nets between its parallel hulls.

The skipper, Capt. John A. Noonan, was in the bridge house, one hand resting on the wheel, the other wrapped around a mug of strong black coffee. Noonan is a weather-bitten harbor pilot with an uncanny knowledge of how tides and winds affect harbor drift.

He unrolled a chart and stubbed his forefinger at the Narrows.

"That's where we're headed," he said. "Sooner or later everything in the harbor will drift through the Narrows toward the Atlantic."

A slow grin creased his face. "I usually wait in ambush for it."

"What kind of drift are we after?" I asked.

"We pick up anything afloat that could be considered a menace to shipping," the skipper answered. "Most of it is scrap lumber, but you can pick up practically anything."

As we moved down the bay at a steady seven knots, Noonan told us that the drift problem in New York harbor causes well over a million dollars' damage to vessels each year. "Even the Driftmaster isn't immune. At least four times a year we go into drydock for a new propeller."



SKIPPER of the Driftmaster, Capt. John A. Noonan, works levers in pilot house that control boom action. Noonan is a sea-wise pilot who likes to wait in ambush for harbor drift.



keeps a safe distance. Ten-ton drift caused ship to list sharply.

CARPET-SWEEPING operations continue after giant piece of a drifting pier has been secured across the forward deck.

The hunting grounds. The fog had lifted and the sun was trying to break through when the Driftmaster reached her happy hunting grounds in the Narrows. Noonan scanned the water with a pair of binoculars, then gave a grunt of satisfaction. He had spotted a "streak."

"In this harbor," he said, "drift accumulates in streaks, along the tide rips."

We were within 100 yards of the streak when Noonan ordered the forward net lowered. Two deck hands, wielding 16-foot pike poles, took posts on a crosswalk in the bow. Noonan bore down on the streak so that most of it would pass between the twin hulls and sail right into the net.

The drift began entering the net, first a few pieces at a time; then, as the center of the streak was reached, in a rush of jagged wood. The net filled steadily.

For the next 20 minutes, I jotted down some of the items that came aboard.

"Truck tire, casing cracked, 10:49 a.m.," my notes began. "Bottom of a bed; scrap lumber; oil-covered whisky bottle (empty); metal refrigerator (without motor); paint bucket; scrap lumber; rocking chair; barrel; vegetable crates; body of large white mongrel dog; cable reel; water-logged piling (crew calls them

'sinkers'—most dangerous); child's beach ball; cushion; book; beach chair; hat boxes; more lumber; blackened life ring; sign ('detour'); a door . . ."

"Sometimes the stuff we haul aboard is valuable," Barsley said. "A tug once hit a barge loaded with oil. We picked up 200 barrels that day. We reported it to our main office, and they saw that the oil was returned to its lawful owner."

Barsley paused, grimaced, and added: "We also get about three or four corpses a year. When that happens, we stop all operations and call the police."

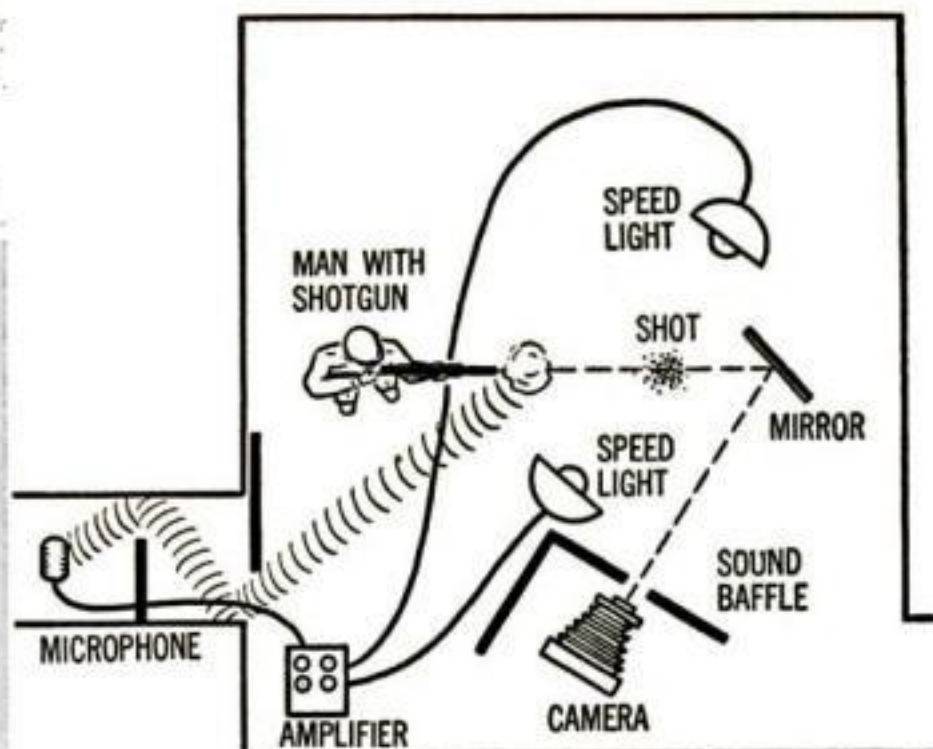
Perhaps the most unusual haul was 16 dozen brassieres a sharp-eyed deck hand spotted in the nets last year. They were soaked but salvageable. For a few days, Barsley recalls, there were 192 brassieres drying in the engine room.

Danger ahead. I went back to the pilot house with Capt. Noonan. The Driftmaster was continuing routine carpet-sweeping when one of the deck hands pointed toward the main channel. Noonan grabbed his glasses and let out a long low whistle. About 500 yards off our bow, and right smack in the main shipping channel, was a complete section of a pier, riding low in the water like an iceberg. When we ap-

[Continued on page 222]



Shotgun blast appears aimed at camera.



Here's how photo was taken.

In front of a shotgun blast

Ever wonder what a shotgun blast would look like headed directly for you?

When Gardner Advertising Co. needed the photo at left to illustrate an ad for Monsanto Chemical Co., its photographer didn't risk having his camera shattered by pellets. He took it through a mirror, rigging his lights to an amplifier so they would flash with the sound of the shot.



Convertible scooter

This British three-wheel cabin scooter with detachable canopy seats a passenger or provides modest cargo space. A two-cycle engine drives the front wheel and swivels with the steering. The Nobletta cruises at 40 m.p.h. and gets 130 miles per gallon. York Noble Industries, Ltd., London, makes it. Price is about \$275.



Handy car-door pocket

This attachment is designed for a door of the Renault Dauphine. It can be fastened to the base of the inside door panel with self-tapping screws. The roomy pocket is made of toughened plastic with bright metallic trim, provides easy-to-reach storage for groceries, cameras, books, and other bulky items.



Reindeer taxis meet incoming planes

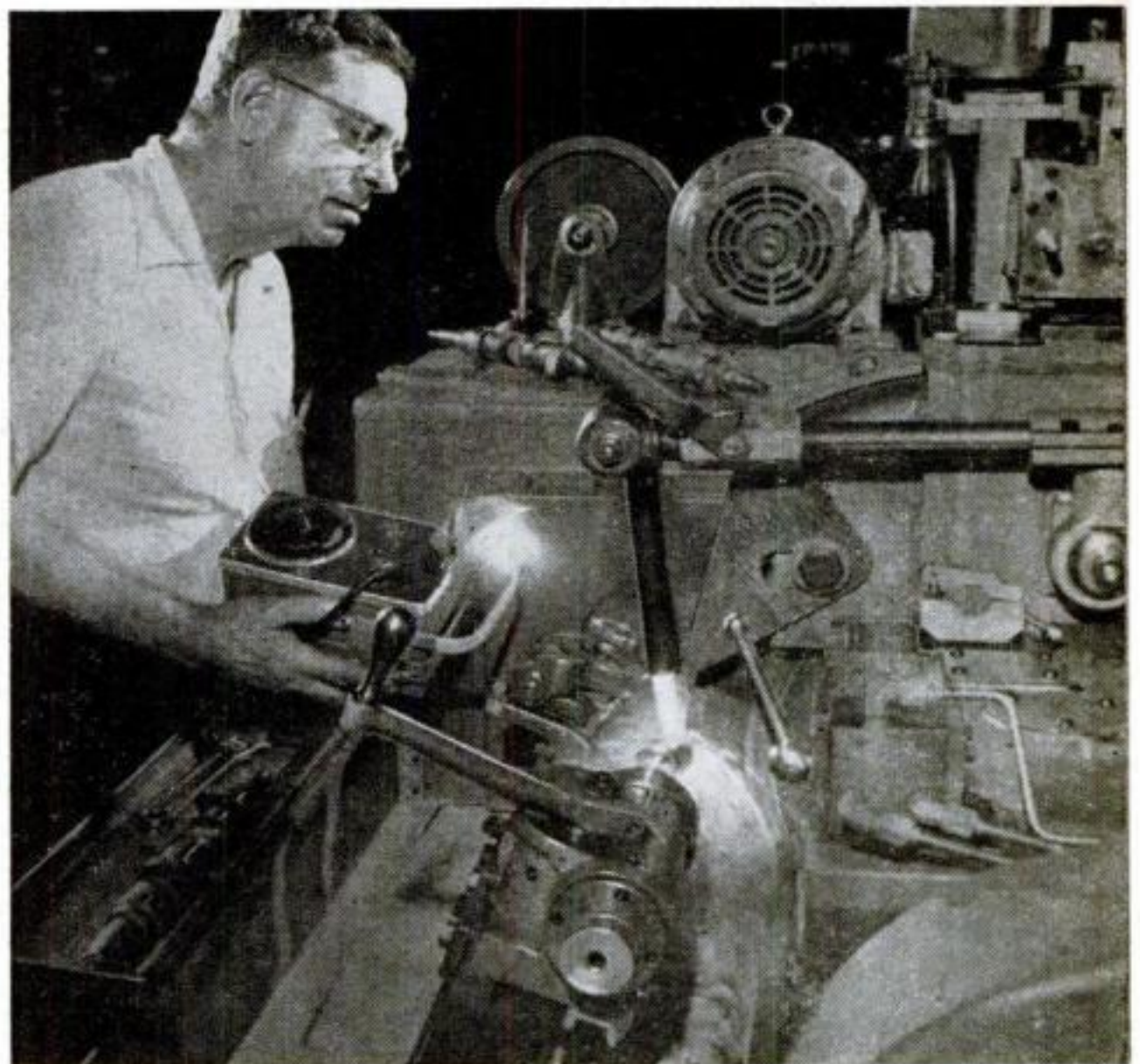
Sleighs drawn by picturesque reindeer and driven by Lapps in native costumes await skiers and other tourists debarking

from a Finnair Douglas DC-3 at Rovaniemi Airport in Lapland. The photo is from an *Aviation Week* correspondent.

Stopping speed in its tracks

This machinist can see exactly what he's doing—as if the high-speed camshaft grinder were standing still—with this improved version of the stroboscope. It emits fantastically short flashes of brilliant white light. Synchronized with machine rotation, they make spinning parts appear stationary.

General Radio's new high-intensity Strobotac can make 25,000 flashes per minute, each lasting less than a millionth of a second. It uses a new flash tube developed by Edgerton, Germeshausen, and Grier to give a sharper view of moving parts.





What Should You Invent?

This is the second article in POPULAR SCIENCE's series on the profits and pitfalls of inventing. Sure you can sell a new idea if it's good—see February PS—but what makes it good? The mystery is stripped away when you ex-

amine the rules professionals use to single out what to invent. You can use them, too, to make your inventions bring in money. Coming up next month is another inside story: How to protect your valuable ideas.

By Martin Mann

THE formula for profitable inventions sounds simple. Listen to Jim Rand, one of the most successful of modern inventors:

"For an invention to make a profit it has to create a business. You can create a business if this invention is cheaper and just about as good as the previous product. You can start a business if it is better, even though it costs a little more. The jackpot is something cheaper and better."

Rand, besides being an inventor himself, is president of a Cleveland firm specializing in inventions. One of his men is Claud Foster, a saxophone player who first hit it big with the Gabriel Horn, an auto accessory that hooked onto the exhaust pipe and played "My Country

'Tis of Thee" at the push of a button. But Foster's specialty is making things cheaper. Years ago he took a hard look at shock absorbers, which are rather expensive.

One day he was driving down a country road and saw a farm boy secure a bull by wrapping its rope around a tree. "That's for me," he said, and adapted the idea to his Gabriel Snubber shock absorber.

The famous Charles Kettering leaned the other way to invent the self-starter. He saw that a great many could be sold, even though they cost much more than hand cranks. Boss Ket's mechanical genius showed up when he seized on a fact that other engineers, blinded by their experience with continuous-running trolley motors, had overlooked: A light-duty motor could be heavily overloaded to

crank an engine if it carried the load only briefly.

Either approach works—if the invention is one that enough people will pay enough money for. That's the point.

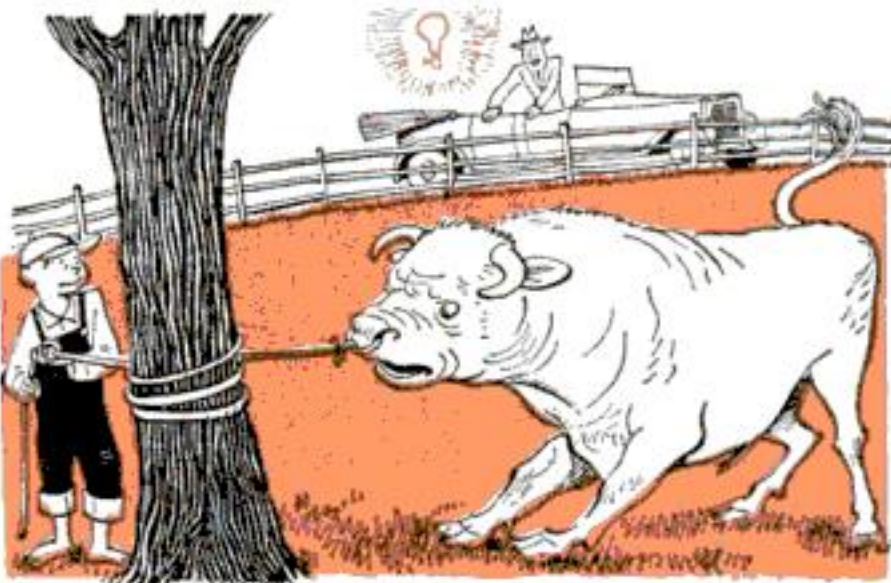
Don't invent just for the sake of inventing

Most amateur inventors ignore this—and miss the pot of gold. "They do things backwards," says veteran consultant Charles Welling. "They jump right in, inventing away, just because they feel impelled to invent. They don't think about markets for their inventions until after the inventions are made. Then it's too late."

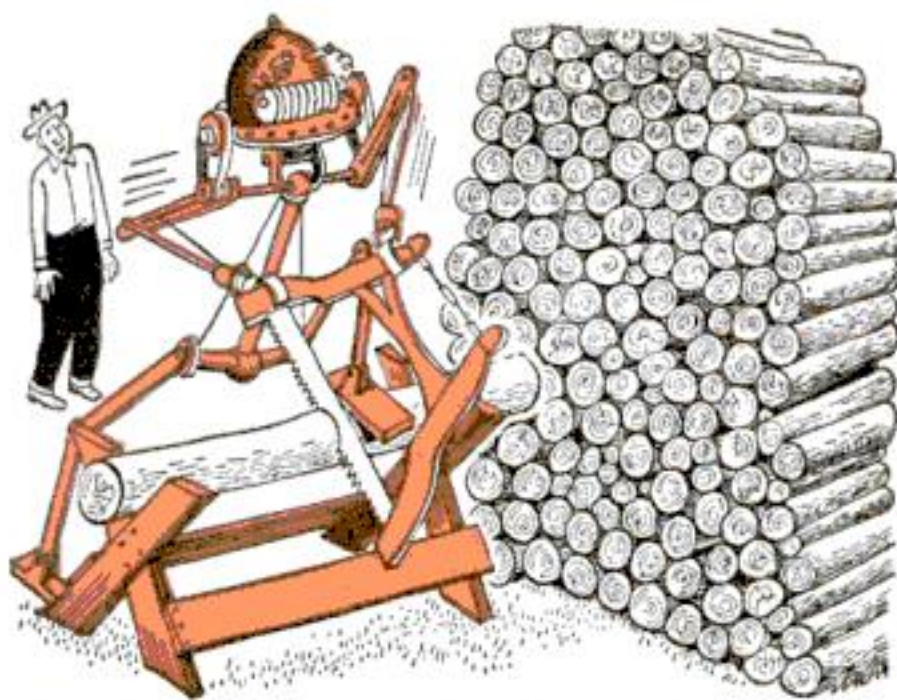
Welling tells of a fellow townsman who rigged up a mechanized bucksaw for cutting firewood. "It worked fine. He had used it for several years, and built a couple for friends. Then he came to me for advice on commercializing his invention. But he hadn't the foggiest idea of how many people might buy such a machine or how much they might be willing to pay for it, let alone what kinds of stores might sell it. He never got anywhere."

How a new kind of machine was born

The big companies that earn dividends on new products do exactly the opposite. Take Harnischfeger Corp., the heavy-machinery manufacturers. At the end of World War II Harnischfeger worried about its crane business. So many cranes had been built during the war that there



Foster watched a farm boy secure a bull by wrapping its rope around a tree. "That's for me," he said, and adapted the idea to his shock absorber.



He rigged up a mechanical bucksaw for cutting firewood. It worked fine—but he never got anywhere with it.

seemed little chance to sell new ones for years to come. Welling was assigned to find a way to keep that division busy. Welling asked himself two questions:

1. Who are the division's customers? Obviously, big construction firms, the contractors who build highways and airports.

2. Where were these customers using hand labor? Hand labor is slow and costly. Replacing it, even with a fairly expensive machine, usually pays off.

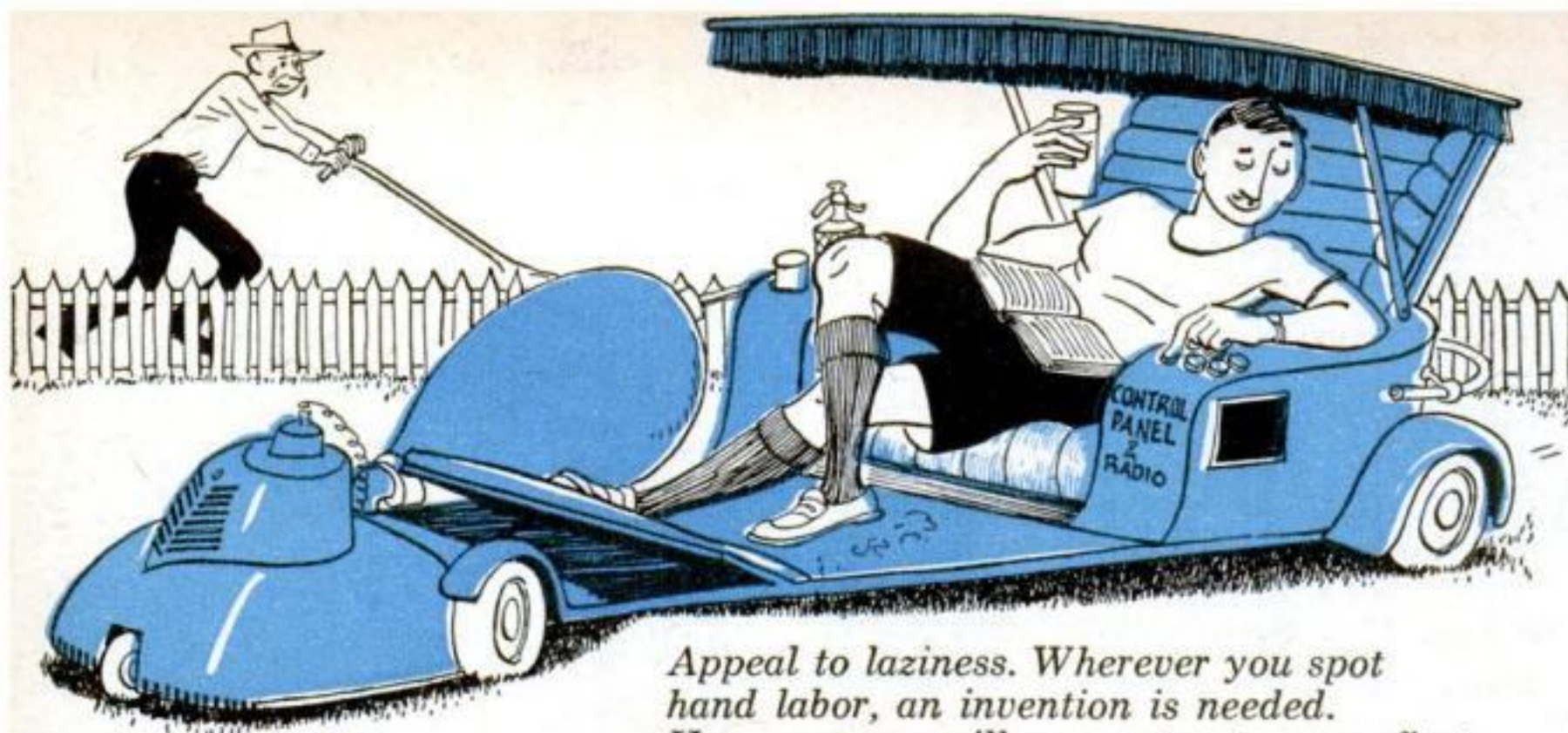
Welling spotted the opportunity in soil stabilization: Harrows, trucks, and gangs with shovels were needed to beef up the dirt foundations under roads and runways.

Only at this point did mechanical inventing begin. Harnischfeger's engineering department got the word and duly produced an ugly but efficient single-pass soil stabilizer. Operated by one man, it munches its way across the landscape, churning up dirt, mixing in the required amount of stabilizing asphalt, and patting the strengthened soil back into place, all in one continuous operation.

As it turned out, Harnischfeger's crane business boomed instead of dying, but that hasn't made the profits on the soil stabilizer any less pleasant.

So who needs it? Before you begin, stop and think

Inventing to please the customers instead of yourself is not always surefire, of course. The biggest corporations have blown millions on market studies only to



Appeal to laziness. Wherever you spot hand labor, an invention is needed. Home owners will pay extra to save effort.

create monumental disasters (just ask Ford about the Edsel). Yet hard thinking before you invent does improve your chances greatly.

Some hints from the experts on what to invent

The men who pay their rent with inventions have learned some rules the hard way. Here's what they do:

- Pick out growing fields: electronics, hobbies, sports, home products, conveniences. (A lucrative example: the Toni home permanent, which Richard N. Harris sold to Gillette Safety Razor a few years ago for \$20,000,000.) Stay far away from dying fields—an improvement in steam locomotives might have founded a fortune back in 1900, but it would be worthless today.

- Work on things you know. You don't have to be a certified expert (the best inventions are usually made by outsiders unaware of what "can't be done"). But if you're *too* green you'll spend years reinventing old stuff.

- Look for products that will be used once, then thrown away, like Reynolds-wrap, Kleenex, tin cans. This promises steady sales (and royalties). The guy who comes up with a good five-cent paintbrush will have it made.

- Appeal to laziness. Wherever you spot hand labor, an invention is needed. Home owners will pay extra to save effort—even small lawns are now cut by power mowers. Businessmen are even more willing to invest in labor-saving machinery

because they get their money back (and then some) in reduced man-hours. Notice the power-operated tailgate elevators on trucks; they're expensive but they pay off. The success of the quick-copying machines (like Thermofax) rests on plain dollars-and-cents. It costs so much to have a typist copy a letter that the machines—at \$100 up—more than pay for themselves.

Small improvements in small products can pay off big

The pros in the inventing business concentrate on small improvements in standard products. That's where the money is. A radically new idea takes so long to win public acceptance that



It costs so much to have a typist copy a letter that the quick-copying machines pay for themselves.

the original inventor may get little out of it.

The zipper, for example. It was invented by E. P. Judson in 1891. Not until 1905 was the Hookless Fastener Co. formed to exploit his patent. And not until the 1930s did the zipper really push aside buttons and hooks. The important, profit-making patent was not Judson's, but later ones issued to Gideon Sundback, chief engineer of the Hookless Fastener Co., for improvements in the zipper and the machines that produce it.

Keep it simple: The Case of the Square Clothespin

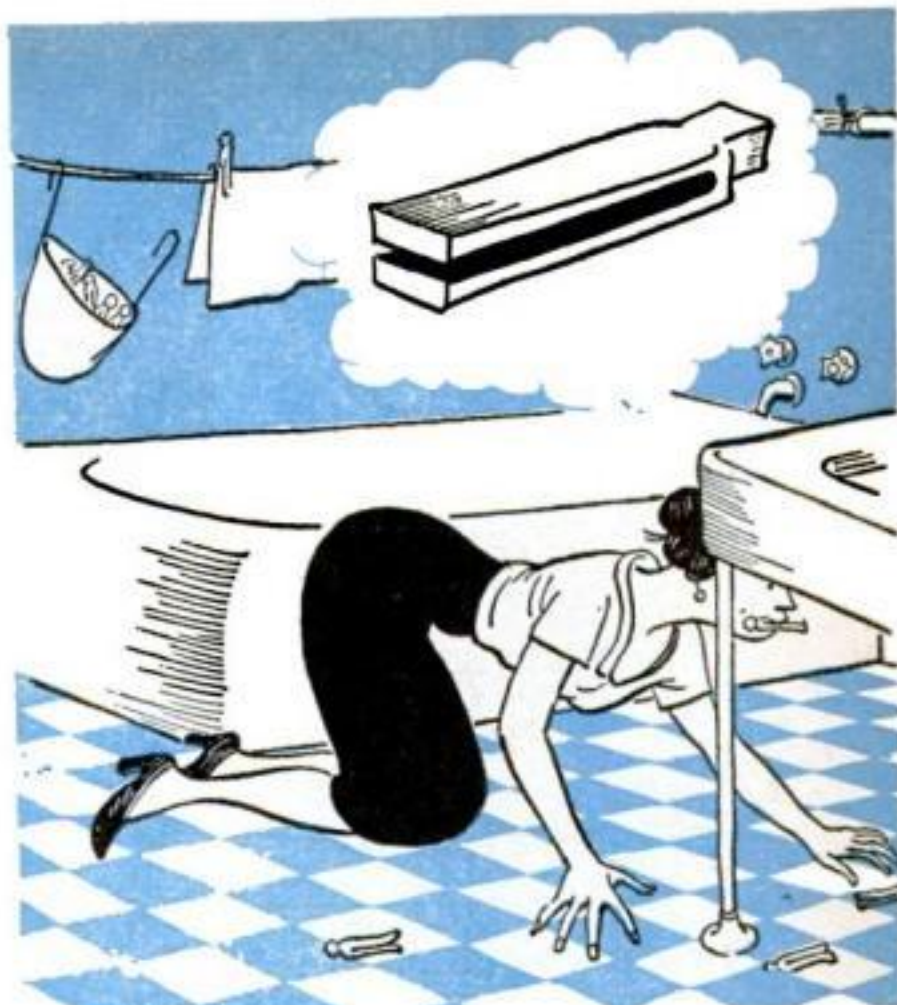
The simpler the improvement the bigger the rewards. A Texas housewife made a fortune because she became annoyed at the way ordinary clothespins rolled onto the floor—and thought up the squared-off clothespin. Another woman made squeamishness pay: Offended by the sight of the toilet-bowl brush, she invented a small disposable mop to eliminate it.

Things like these, in everyday use in ordinary homes, are best for independent inventors to aim for. You already know the requirements. You can build and test experimental models with little trouble. And you'll get more attentive consideration from manufacturers of consumer goods.

A few rules to follow about what not to invent

It's easier to pinpoint what not to invent. Some fields are overcrowded. So many varieties of bottle caps and tube caps have been tried that the chances of hitting on a successful new idea are slim. More than 6,000 patents have been issued on self-locking nuts, and dozens of efficient types are already on the market (yet inventors keep right on devising new ones). You can get a patent in a crowded field, but it's not likely to be worth much. It will be so "narrow"—pertain to such fine details of design—that a smart engineer can work his own design around it.

Some fields are tough to crack, among the toughest being automobiles. One auto maker looks at about 8,000 ideas a year, but buys only eight. Even when a deal



A Texas housewife became annoyed at the way ordinary clothespins rolled onto the floor—and invented the square clothespin.

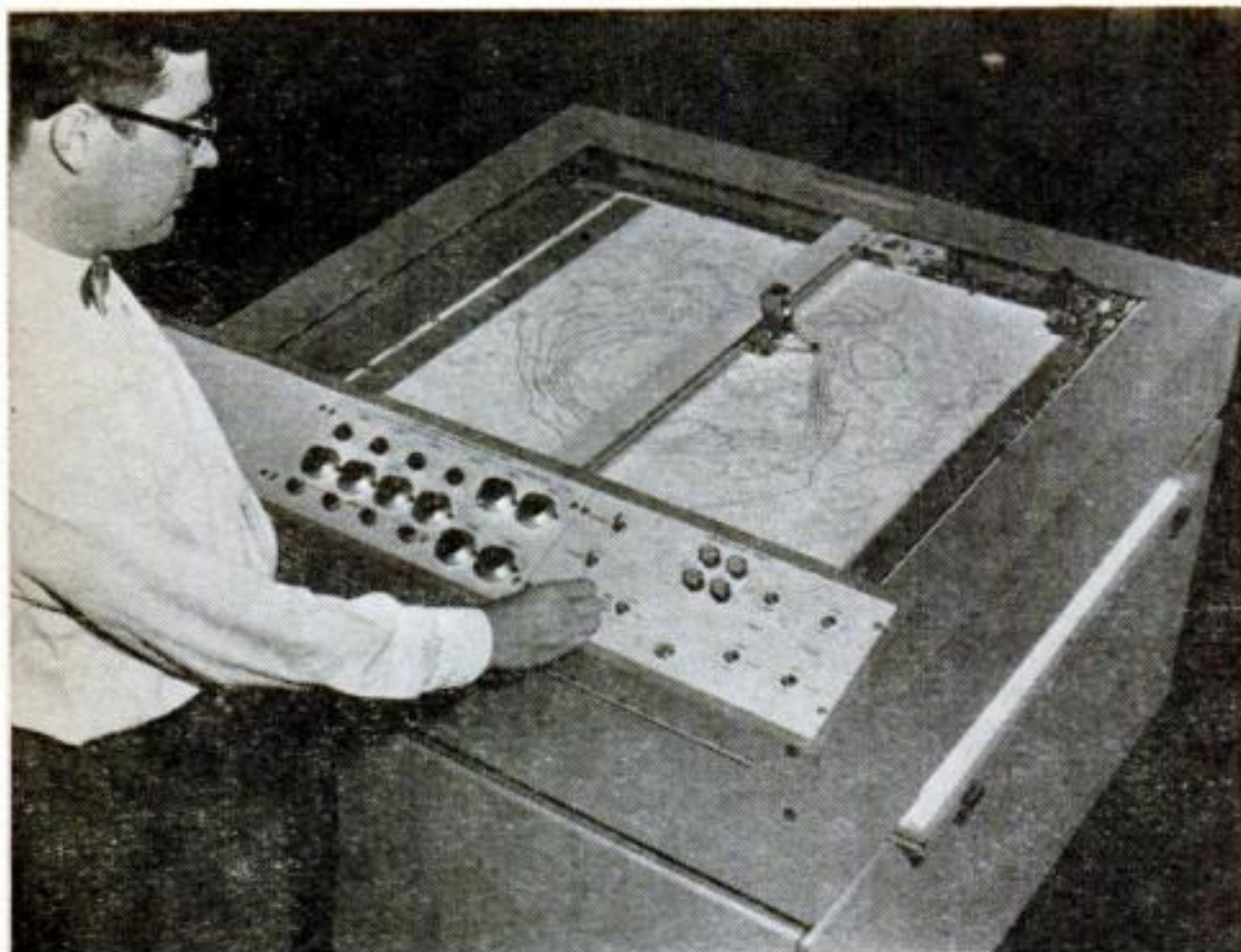
is made, the terms are rarely generous. You have only five possible customers for an automotive invention; if they don't buy, you have nowhere else to go. (There is a good market, however, for auto accessories that don't have to be installed at the factory; the many small and medium-sized manufacturers in this business are looking for new ideas.)

The prospects for an airplane invention are even more dismal. Most aircraft manufacturers pool all patents, so no single firm has much to gain from buying an idea on the outside. While the pool itself occasionally buys a patent from an independent, it is the one and only customer and can set the price.

And perhaps most important of all . . .

You should be ready to break any rule. Last summer one esteemed independent inventor, ticking off his own private list of dead fields not worth wasting time on, included flypaper. It certainly seems obsolete in the DDT age. Yet only recently scientists have discovered powerful chemical lures that will attract bugs for miles around—to meet extinction on flypaper.

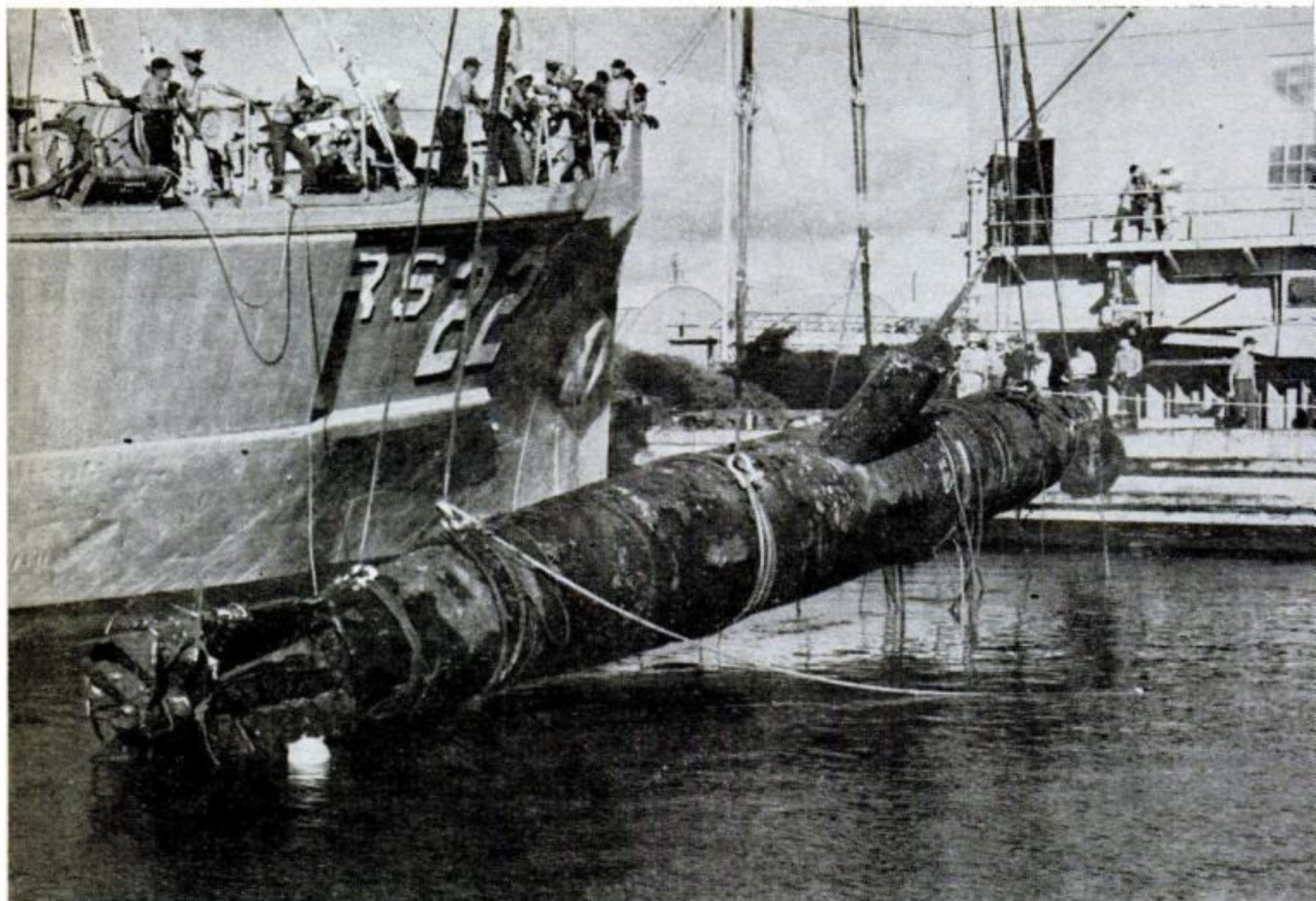
Maybe there's hope even for steam-locomotive inventions.



Maps plotted by electronics

This electronic computer is fed weather information on tape, reads and interprets it—and in three minutes comes up with a 30-by-30-inch weather map of the Northern Hemisphere, isobars and all. Hand-plotting takes 20 minutes.

The computer-plotter was built for the Weather Bureau by Electronic Associates, Inc. It's making maps at the National Meteorological Center, Suitland, Md.



Midget Jap sub recovered

This corroded two-man submarine was raised recently from waters off Pearl Harbor—19 years after the Japanese attack that got us into World War II. It was discovered accidentally on a bed of coral

70 feet below the surface during Navy diving practice. Damage indicated it succumbed to a U. S. depth charge before the two torpedoes it carried could be fired—they were found and dismantled by bomb experts. The crew apparently escaped through the open conning tower.



Helicopter lifts van off wheelbase . . .



. . . deposits it on freighter in river.

Fly-off, fly-on freight by helicopter

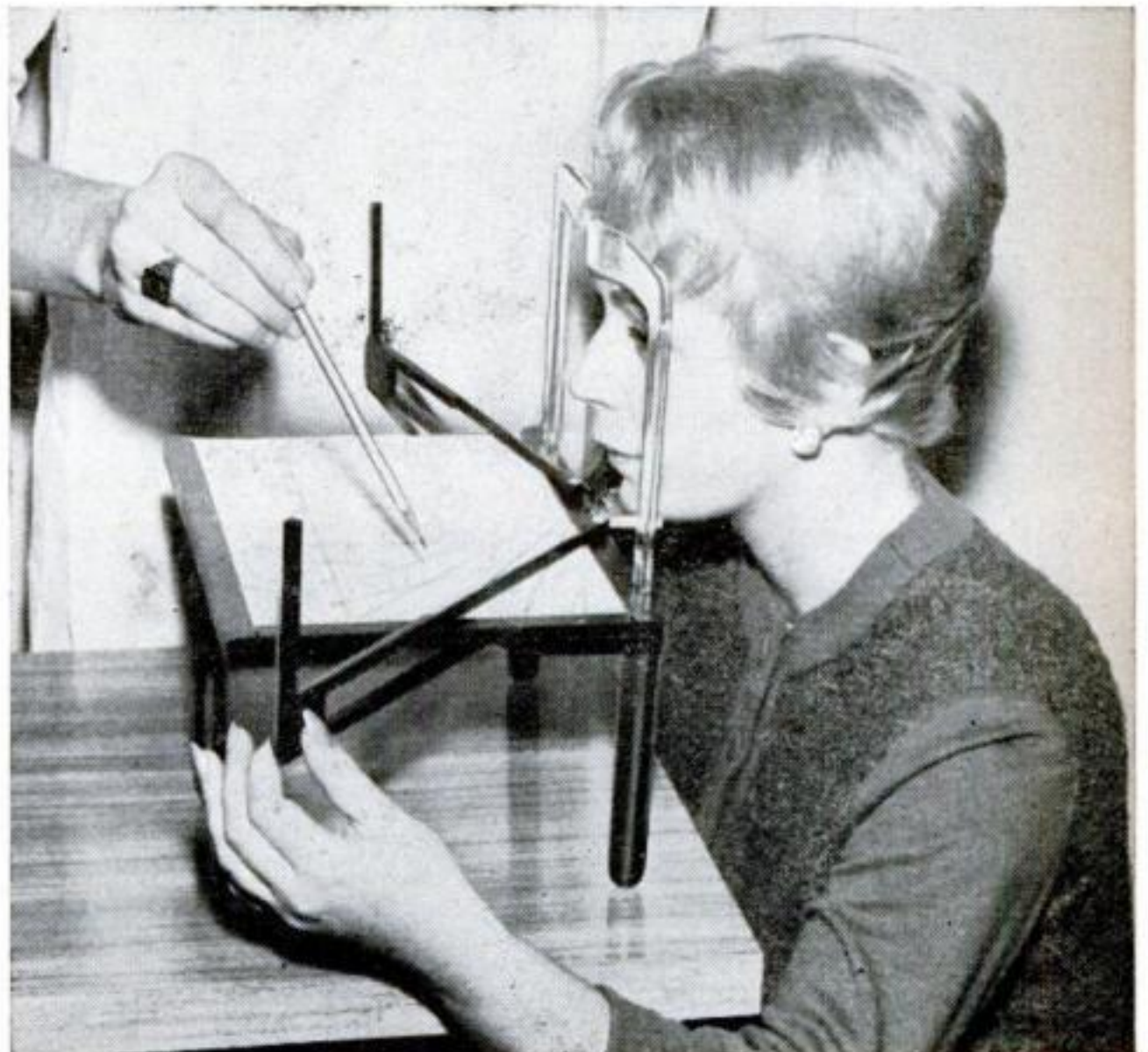
The first aircraft to load cargo direct on an ocean freighter here lifts a truck-size container onto a ship in New York's Hudson River. The van rode piggyback on a flatcar into New York Central's Weehawken, N. J., yards, was hauled by

truck trailer to the pier, unhitched, picked up by a Sikorsky S-60 Skycrane, and in minutes pinpointed on the deck of a U. S. Lines freighter. Participating in the demonstration were Strick Trailer Co. and a dozen freight carriers.

Device tests side vision

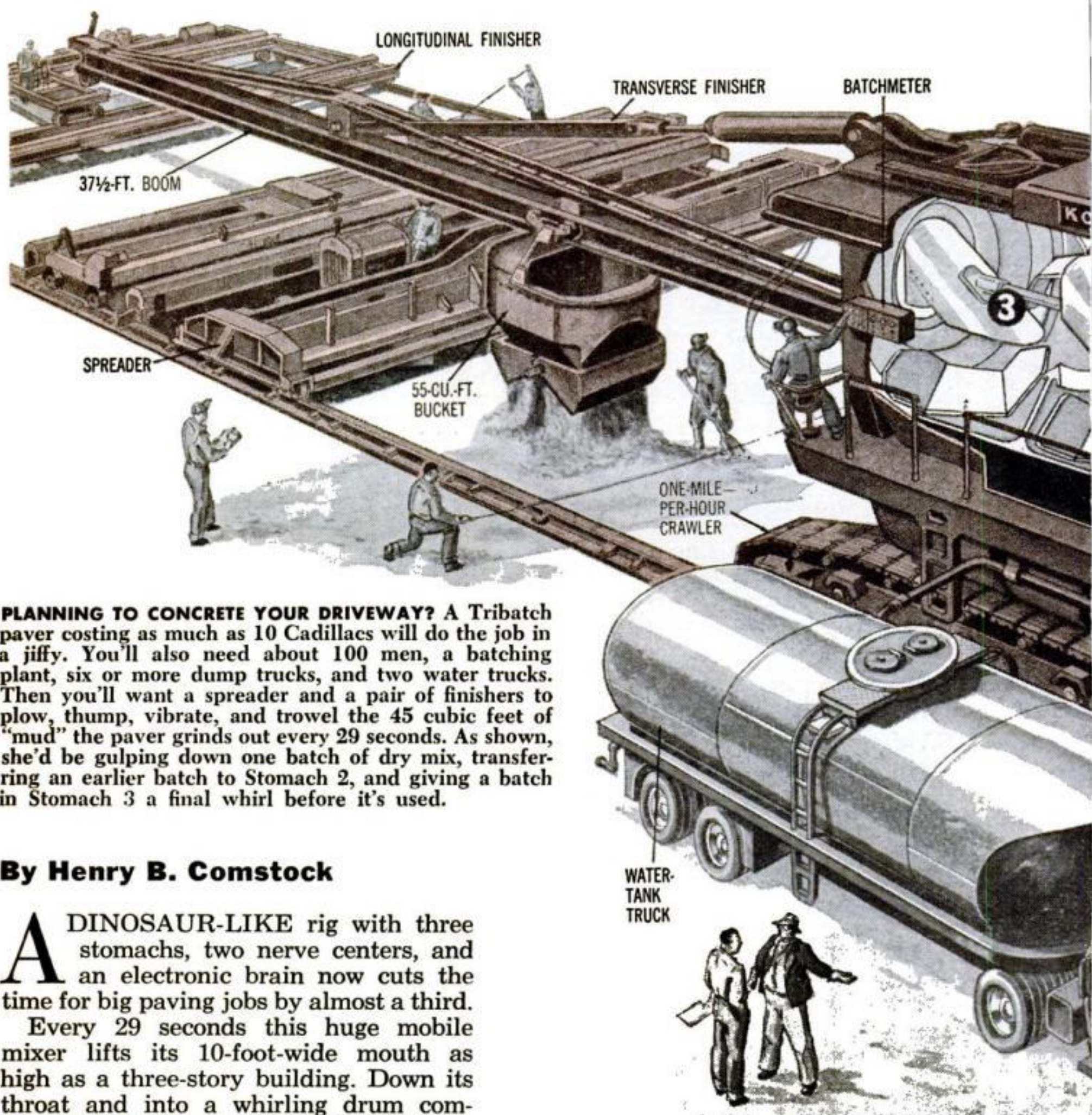
With a subject gazing straight ahead and the sticks moved in until she can just see them, this Perimetric Screener measures her vision to either side.

It was developed by Dr. Theodore A. Brombach, Pacific University researcher, who used it to test peripheral vision of football-pass receivers, moving them to the other side of the line if their sight was better there. The National Eye Research Foundation will try it on motorists, pilots, and industrial workers. Side vision might be helped by contact lenses.



Biggest Concrete Paver

This monster with a 10-foot mouth swallows 80 cubic feet of mix a minute, digests it one-two-three, and spews it forth



PLANNING TO CONCRETE YOUR DRIVEWAY? A Tribatch paver costing as much as 10 Cadillacs will do the job in a jiffy. You'll also need about 100 men, a batching plant, six or more dump trucks, and two water trucks. Then you'll want a spreader and a pair of finishers to plow, thump, vibrate, and trowel the 45 cubic feet of "mud" the paver grinds out every 29 seconds. As shown, she'd be gulping down one batch of dry mix, transferring an earlier batch to Stomach 2, and giving a batch in Stomach 3 a final whirl before it's used.

By Henry B. Comstock

A DINOSAUR-LIKE rig with three stomachs, two nerve centers, and an electronic brain now cuts the time for big paving jobs by almost a third.

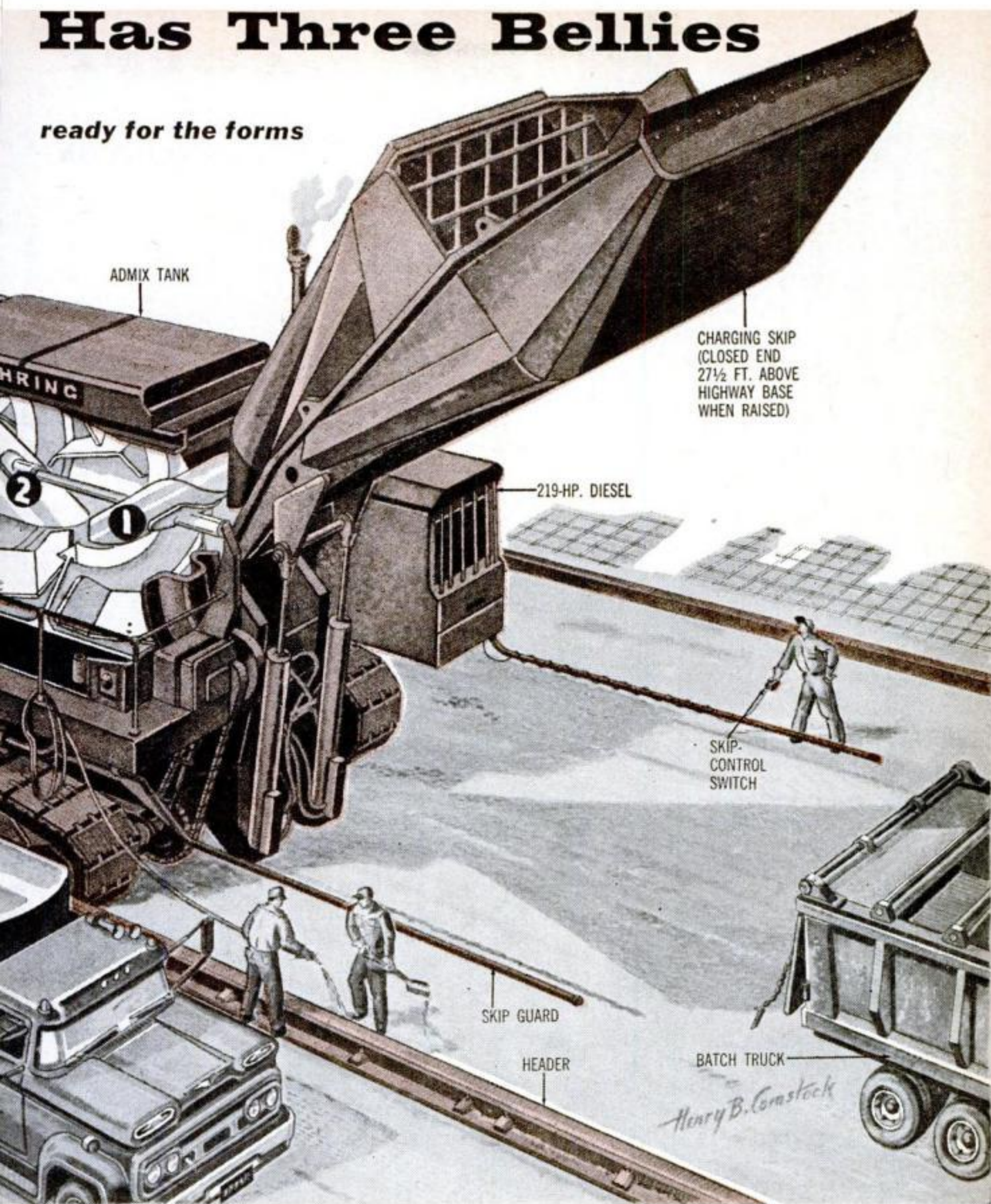
Every 29 seconds this huge mobile mixer lifts its 10-foot-wide mouth as high as a three-story building. Down its throat and into a whirling drum compartment rattles 40 cubic feet of dry gravel, sand, and cement. Simultaneously, an earlier batch, blended with just the right amount of water, tumbles into a second compartment. In still a third, a fully churned mix is ready for transfer to a boom bucket that will dump it between the forms, or "headers," of the

highway wending its way to the horizon.

It's this one-two-three routine that sets the new Koehring Tribatch mixer apart from all former machines. Shoving the batter along at the rate of 124 charges an hour, it whips up the makings of half

Has Three Bellies

ready for the forms



a mile of two-lane highway every work day.

An old trick made better. Upping performance by sending concrete through a mixer in lapping cycles isn't new. More than 30 years ago the Koehring Co., along

with other outfits, developed a dual-drum paver. That was a neat way around a problem common to manufacturers in many industries: You can't always make a good rig better simply by building it bigger.

CONTINUED

119

Within a single working day, the Tribatch can whip up



PIPE EXTENSIONS on either side of the skip keep workmen from walking under this 2½-ton loading chute when it's raised. The one at right also

holds the skip-control switch. A 37½-foot-long bucket boom at the rear lets the Tribatch work inside or outside the headers.

In paving, the pattern has always worked like this: When the final grading is finished, you place a batching plant midway along the road base. Or, if you're slabbing more than seven miles, it pays to set up batching plants at two locations. There, you blend gravel, sand, and cement. A steady procession of trucks picks up the dry stuff, scoots to the work site, and pours it into the paver's skip. So far, so good.

But very early in the game, contractors began to chain-gang these rigs, using two or three pavers as a team. This doubled or tripled production, as long as the outfits took the same charge. Now suppose you bought a new paver, half again as big as another. You were in trouble. Either you had to run two fleets of trucks, or lose time metering different amounts of dry mix into each skip.

The dual-drum paver was the answer. Working with single-drum outfits, it gulped down identical charges and gave them the same tumbling time. Only the cycling was speeded up. Operating the same way, the Tribatch is a logical successor to the dual-drum job.

Mudslingers never had it so good. The man at the controls of a paver has never had time to take up tatting. On the simplest machine he must raise and lower the skip. Then he must dump just the right amount of water into the mixing drum, haul in his bucket to receive each charge, and send it skimming along a boom angled this way or that to spot the concrete where it's wanted. At fre-

quent intervals, too, he must inch the paver forward.

When dual-drums came along, operators had another chore. Between the two compartments was a transfer chute, pivoted on a shaft that ran through the center of the barrel. This had to be given two half-flips each time a charge went through. In a Tribatch there are two of these scoops (in addition to the usual bucket loader). No one operator could handle the resulting rapid-fire routine.

He doesn't have to. As a matter of fact his job has become so easy that one mudslinger has worked up an act for visiting firemen. As soon as he places a batch he swings down from the control platform and takes a simulated nap on the shoulder of the grade. Meanwhile the drum rumbles nonchalantly.

Electronic brain flexes muscles. A box about four times the size of a dinner pail controls all cycling operations in the Tribatch drum. Once scheduled, it determines just when—and how much—water will enter the first compartment. Occasionally, contracting requirements call for additional digestive juices in the form of chemicals, to give the concrete special characteristics. An admix tank above the drum can be filled with the fluid and set to dribble any amount up to 40 ounces into each charge.

In addition, the "batchmeter"—that's what Koehring calls the electronic brain—flips each transfer scoop after a predetermined number of seconds. Some leeway is needed here. For example: A

the makings for a half-mile of two-lane highway

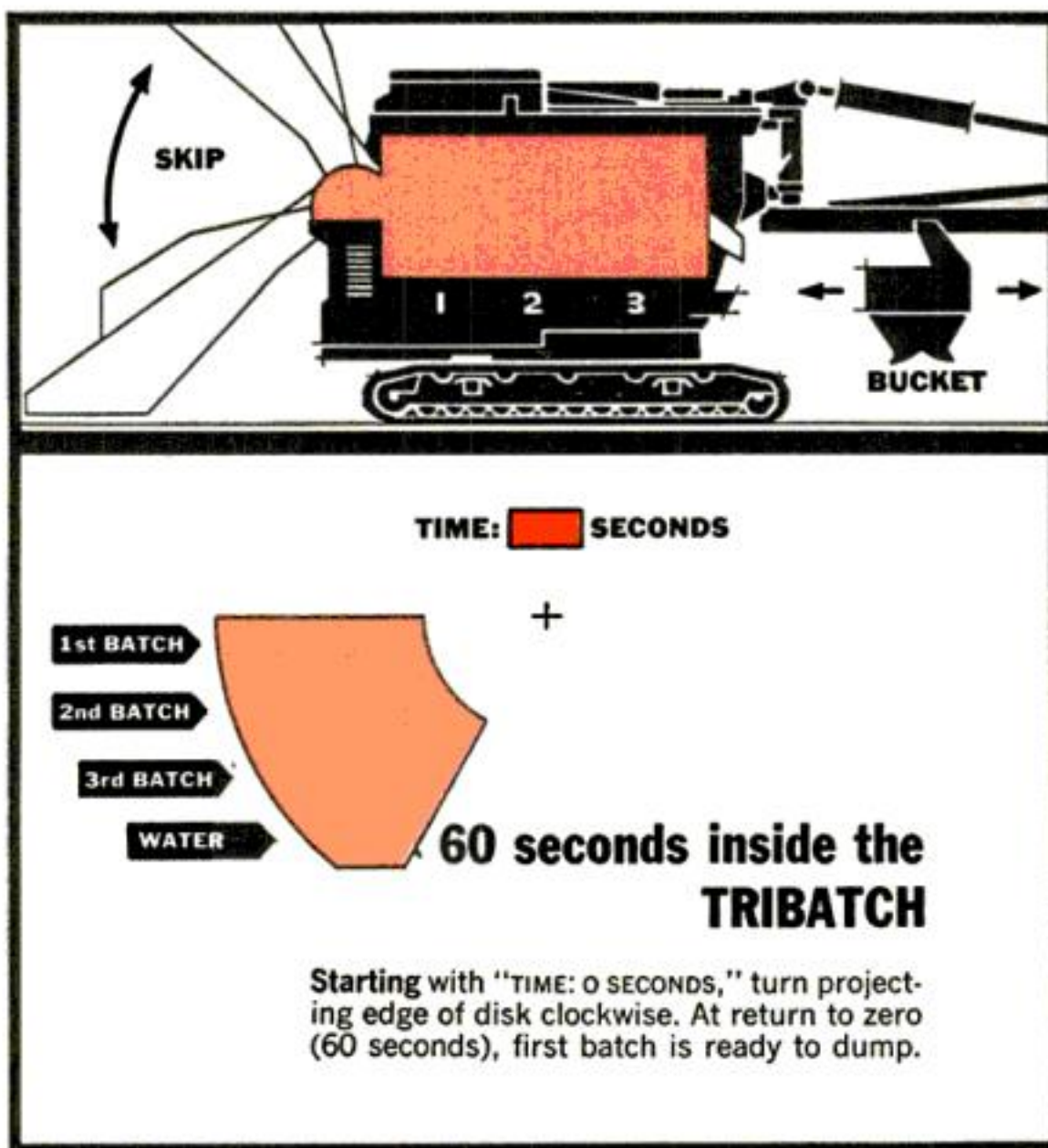
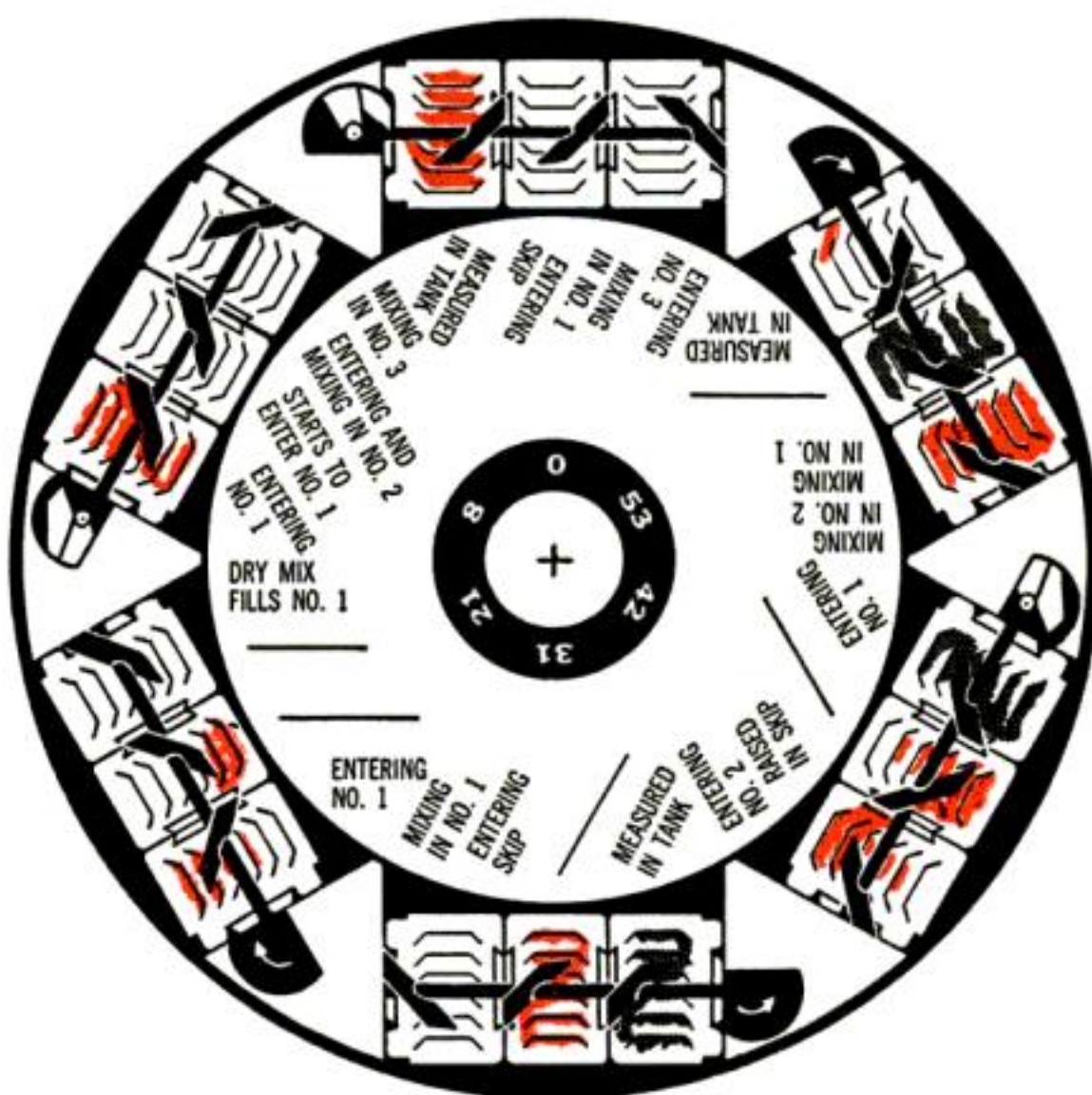
heavy non-slumping mix used on a steep highway grade or heavily banked curve can't be put through as fast as ordinary batches. Finally, both the skip and the bucket-loading chute work automatically—but only with these two safeguards:

The dump man who waves trucks into position for charging now punches a button to set the skip in action; until he does it can't budge. At the other end, the scoop can't flip until the bucket is spotted below it.

It all adds up to an efficient machine. So efficient that one contractor who teams his Tribatch with a two-drum outfit says it costs him \$15,000 every time he starts them. He's talking in terms of the overall picture—a 175-man payroll, a batching plant, a battery of spreaders and finishers, 12 dump trucks, and four tank trucks. One of the tankers is hose-connected to each paver; when these two are empty they run for water and the other pair takes over.

At day's end, too, there's a Herculean cleanup job. It takes two hours to flush down a Tribatch. Then about once a month, a hammer man goes into each drum compartment through a special crawl hole, and does a chipping job on the blades and scoops.

Nobody is even willing to think about what would happen if some nightmare mischance should let tons of concrete set rock-hard inside the giant machine. It *can't* happen, they tell you, and roll up their eyes at the very thought.



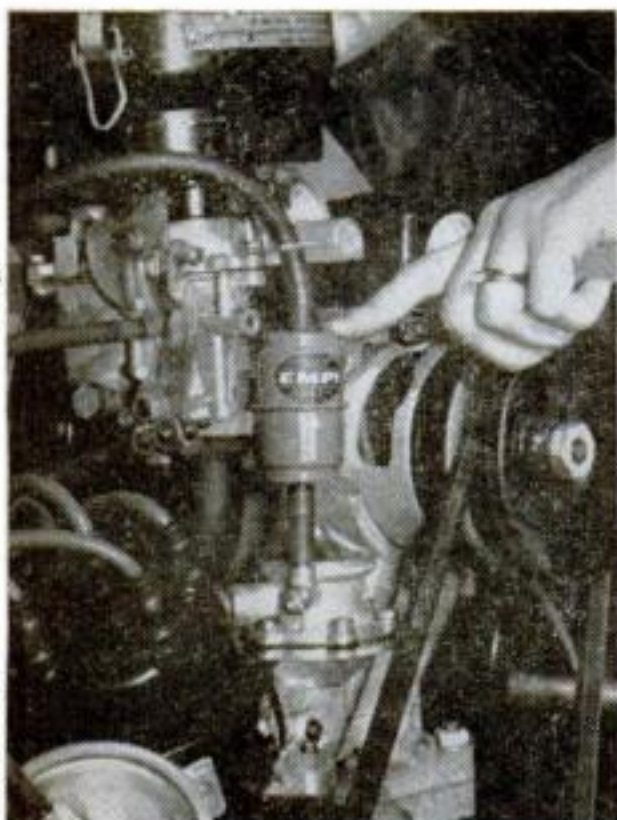
FOR AN X-RAY VIEW of the Tribatch in action, mount the disk and rectangle on cardboard and trim around the edges. Cut out colored areas on rectangle, and pivot the disk behind it with a paper fastener pushed through holes at crosses.



Remote-Control Movie

Insert film in this projector, sit back, and take it easy. The Dual/Lectric does all the work: threads the film automatically, turns off the room lamp, and turns on the projector.

In addition, a no-knob remote-control cube when turned in your hand starts, reverses, or stops the show for viewing a still. It's done by mercury switch, with a pilot light to show position. \$239.95 up. Bell & Howell, 7100 McCormick Rd., Chicago.



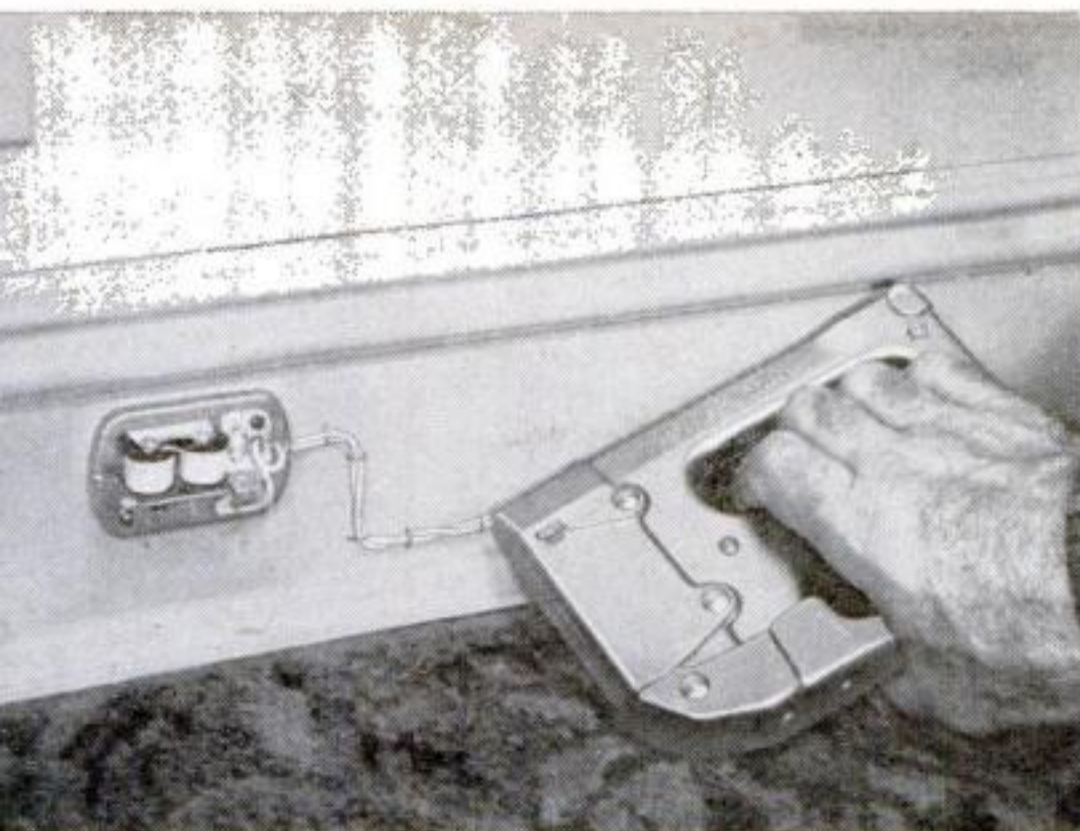
IN-LINE FILTER removes water and dirt from fuel lines to '61 Volkswagen engines. Gasoline passes through a sintered-bronze screen. You clean the unit by reversing and flushing it with gas. Price, \$3.95. European Motor Products, Box 668, Riverside, Calif.



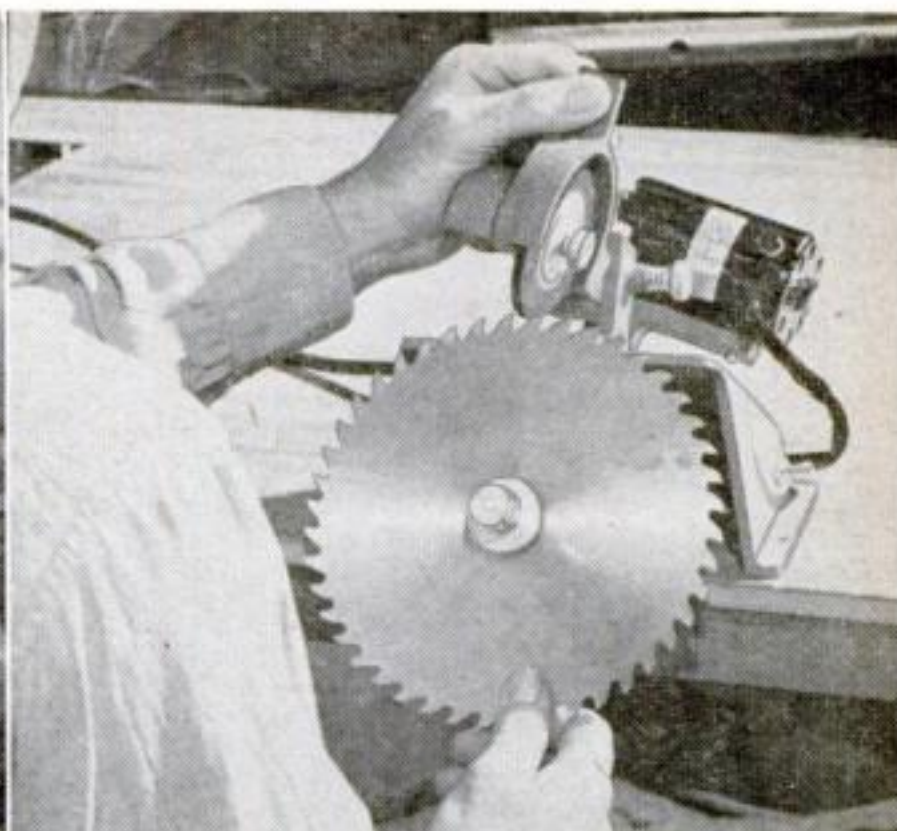
TILE PATCHER is a white mastic that will anchor loose tiles, seal a gap between tub and wall, and do other calking jobs. The waterproof adhesive is non-cracking, and can be smoothed with a wet finger. Tube costs 98 cents. Devcon Corp., Danvers, Mass.



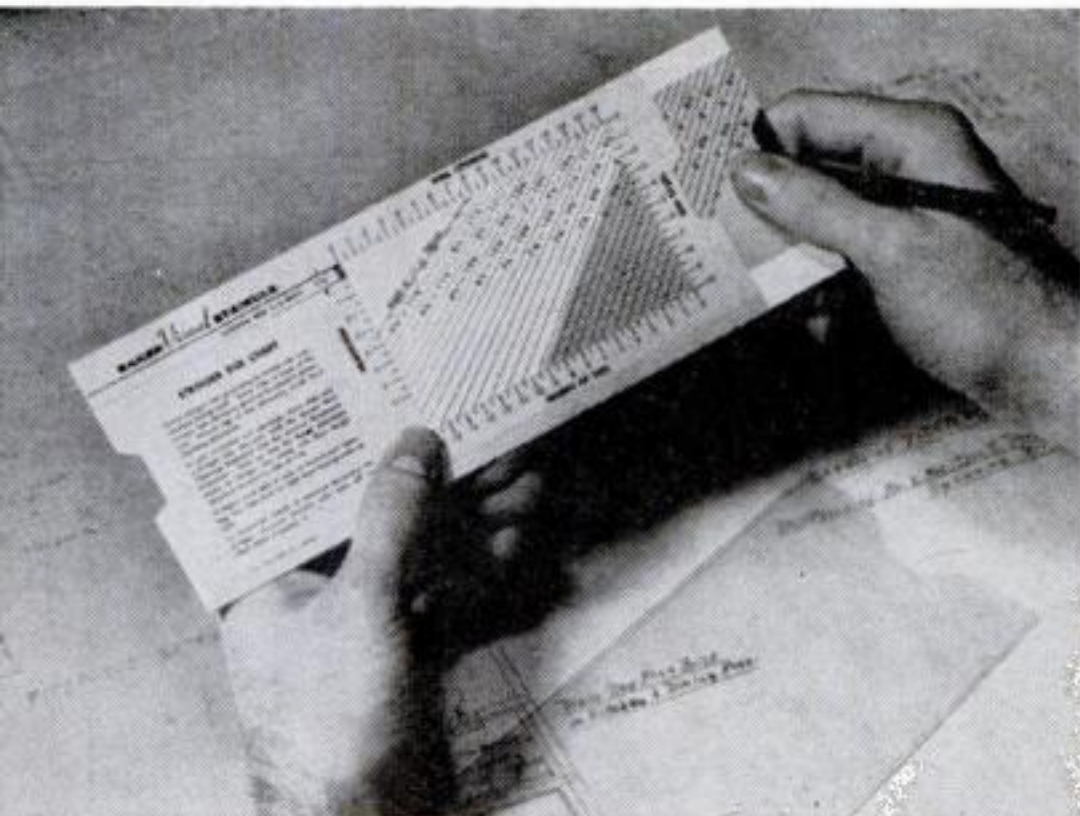
AIR CLEANER is an electronic filter so compact it fits between blower and return duct of forced-air furnaces. Living-area control panel even tells you when to wash filter. \$325, plus \$75 for air-conditioning unit. Minneapolis-Honeywell, Minneapolis.



BELL-WIRE STAPLER drives staples just deep enough so you don't compress the wires, squeeze or break the insulation. Gun can be used for low-voltage wire up to $\frac{1}{4}$ -inch diameter. Staples come in four sizes: $\frac{9}{32}$, $\frac{3}{8}$, $\frac{7}{16}$, and $\frac{9}{16}$ inch. Gun sells for \$15, staples for \$1 a thousand. Arrow Fastener Co., 1 Junius St., Brooklyn, N. Y.



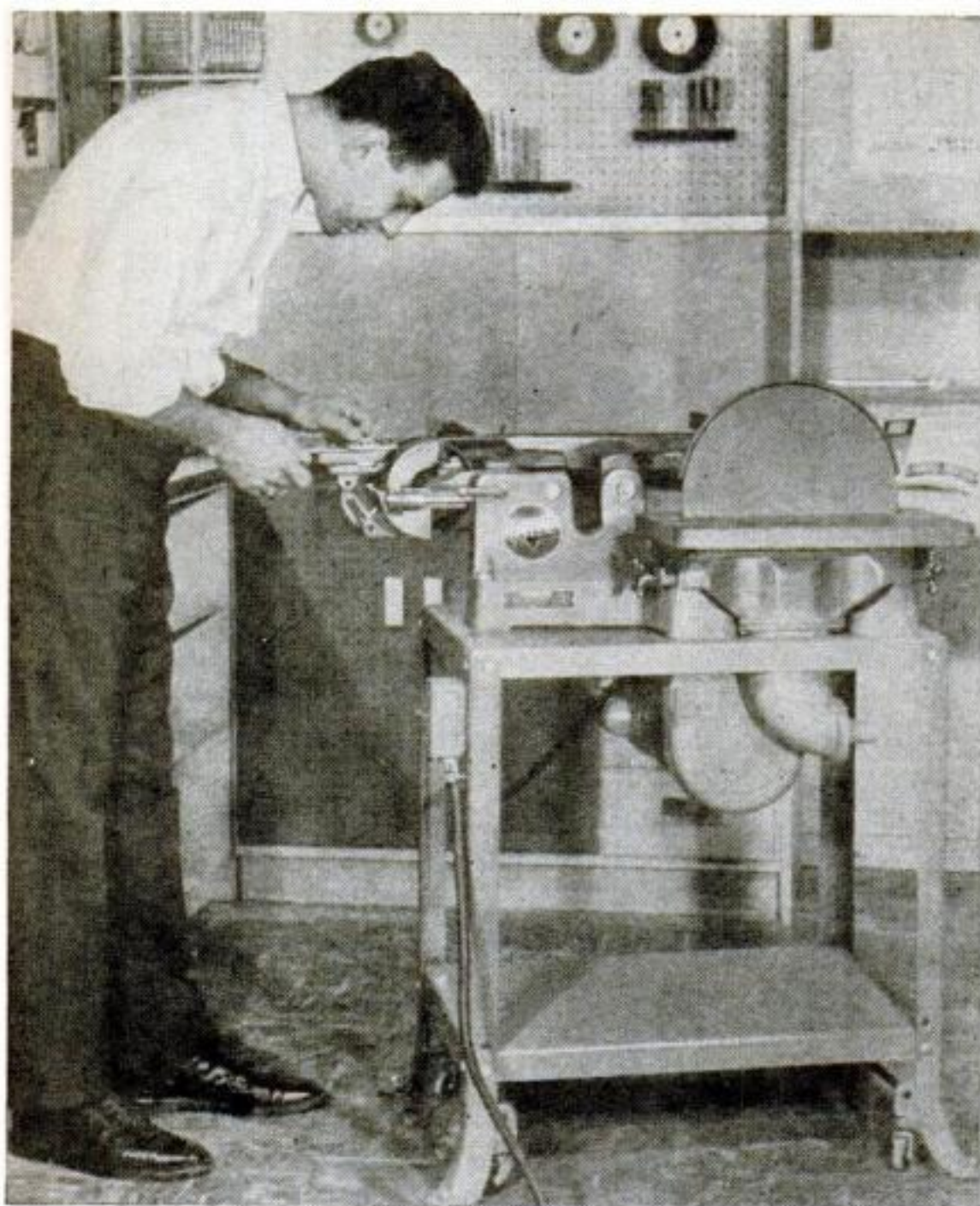
SAW SHARPENER is driven by electric motor, has cam action that holds each tooth in place for edging and setting. You can use it for a 4- to 24-inch-diameter blade. Attachments sharpen chisels, router bits, scissors, knives; chain-, hand-, and band-saws. \$95.50 without attachments. Easysharp Corp., 919 Fulton N.E., Grand Rapids, Mich.



STAIRWAY COMPUTER gives you unknown dimensions when laying out a stairway for any opening. By setting the known total rise, you can read directly proper number and height of risers and other combinations. Another setting gives number and width of tread needed. Transparent window provides visual reproduction of stair problems. \$3.95. Emmert Products, Box 221, Sycamore, Ill.



STATION-WAGON PORCH converts the interior of most models (except Rambler) into sleeping quarters for two or three people. The extension is made of water-resistant canvas with an opening of nylon mosquito netting. You can install it in two minutes, open or close curtain from inside. It stores easily. Price: \$23. Morsan Tents, 10-27 50th Ave., Long Island City, N. Y.

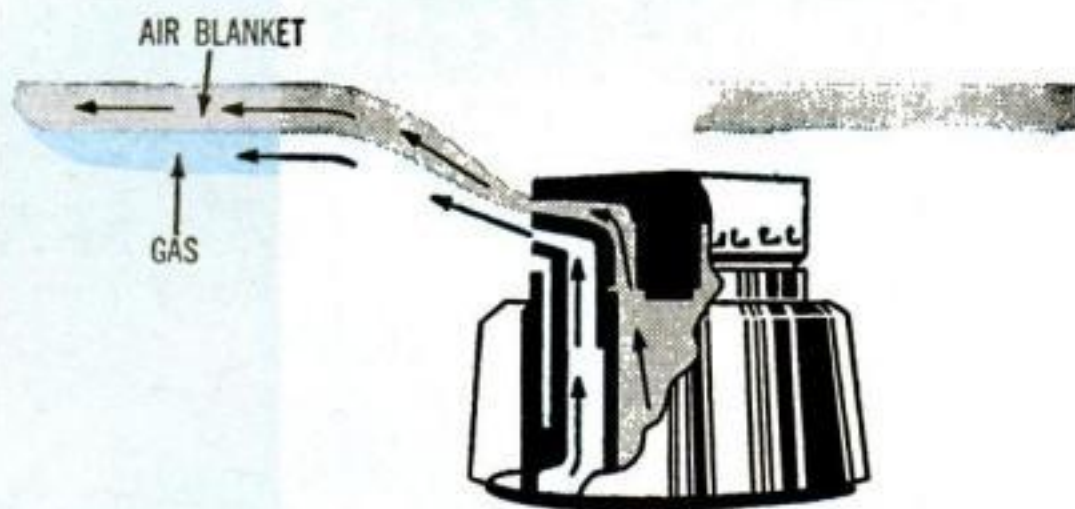


Sander Can Grind Tools

This heavy-duty belt and disk sander can be had with a special attachment for sharpening knives, chisels, plane blades, lathe cutting tools, and screwdrivers.

The basic tool comes with a 4-inch belt and 12-inch disk, has special castings that can be connected with a dust collector. The tool-grinding attachment uses a 2-inch aluminum-oxide belt 52½ inches long that dissipates heat, avoids burning because of its long run.

Sander, \$134.50, without enclosed motor, stand, or accessories; tool grinder, \$15.90. Delta Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh.



AIR BLANKET in a new range keeps flame away from utensil, lets a cook melt chocolate in wrapper, cook sauces in glass. Extra air, provided by a built-in fan, comes from inside the burner. Blanket-O-Flame range, \$179.95. Whirlpool Corp., St. Joseph, Mich.



COMPACT TRAILER rides highway with a manageable 62-inch height, but at night you can crank up the top section for head room for a six-footer. Nimrod Five Star can sleep up to five adults,

has a floor heater for chilly nights, includes a kitchenette with refrigerator, sink, and water tank. It's made of aluminum and steel, sells for \$1,395. Ward Mfg., Inc., 2530 Spring Grove Ave, Cincinnati.



FOAM HEADREST shaped to fit the nape of your neck attaches to the back of car seat. You can adjust height and angle for upright driving or for off-road napping. It's priced at \$8.95; \$16.95 a pair. Mark Mfg. Co., 4230 Commercial S.E., Salem, Ore.



SPRAY-ON GLUE can be used on paper, plastic film, fabrics, upholstery, and other materials. The transparent, odorless adhesive dries rapidly, but leaves time for you to reposition items. \$1.95 for 12-ounce can. Avery Label Co., 117 Liberty St., NYC.



BOTTLE OPENER removes cork by pressure of carbon-dioxide gas released through a puncturing needle. You can open 30 bottles with one cartridge. Cork-Ace sells for \$10; a box of 10 cartridges costs \$1.19. Bloomingdale's, Lexington and 59th St., NYC.

Why People Walk in Their Sleep

We are learning more about the weird behavior of the somnambulist—and why he prowls the night in an eerie state between waking and sleeping



By George J. Barmann

ONE night a few months ago, a freshman at a West Virginia college got up from bed and walked slowly through the dormitory until he found a room with an empty upper bunk. He climbed up, sat there as though he were behind a set of controls, and said, "Let me drive this bulldozer!"

The youth, who had been working the past summer on a construction gang, was a sleepwalker. More than once, he had gone on these night rambles, usually winding up with the same ghostly performance. It bothered his dormitory mates until they had a chat with the college doctor.

Sleepwalking, the boys were assured, is fairly common. Every night, all over the country, people arise without waking, wander through the house, even venture outdoors for miles before getting back—often with the help of others—to their beds.

Sleepwalkers are careful. In their strange midnight parade, sleepwalkers usually make their way quietly and carefully from room to room, as did the college student in his dorm. They go up and down stairs, draw bolts or turn keys, open doors. In some cases the acts are more complex: They sit down and write letters, or play the piano, or do school homework.

Occasionally, they get out of windows and inch along narrow ledges, or stroll to the neighborhood corner and cross unharmed through traffic.

Reports of the weird roving of sleepwalkers—or somnambulists, as they are called—are known to almost every family doctor.

An Iowa farmer, who had won blue ribbons at the county fair for his crops, got up on summer nights, slipped his overalls on top of his pajamas, and ambled along between the moonlit rows of corn, patting the fresh, green blades.

At Camp Lee, Va., a 19-year-old soldier put on his dress uniform and went tramping across the black countryside, looking for an uncle.

A Tampa, Fla., metallurgy assistant, who regularly took two bananas to work in his lunch box, often wandered from his own house to his mother's kitchen next door and ate a dozen before returning to his bed.

A Los Angeles youth fell from his second-story window, bounced off an awning, broke his wrist, and then walked for five blocks before his family caught up with him and awakened him.

An Iowa farmer got up on summer nights and ambled along the rows of corn.



A Florida man often wandered over to his mother's kitchen next door and ate a dozen bananas.



A New Jersey man was found one night starting to climb up from the window of his sixth-floor apartment.



She drove away in her husband's auto and woke up beside the freeway, 23 miles from home.

Physicians say there are from 2,000,000 to 4,000,000 sleepwalkers in the United States. But exact statistics are difficult to gather; many persons are reluctant to report the experience.

A *"dream acted out."* Sleepwalking is an eerie state between waking and sleeping. It is sometimes described as a dream that is acted out. Doctors say it is an "abnormality of sleep" that usually comes when sleep is the deepest—within the first two hours or so after you drift off. It is most evident among young persons; at least it is most often reported then. A short-circuit occurs somehow in the sleep mechanism, and the sleeper is moved to unconscious action that he seldom recalls later.

The body, in sleepwalking, is directed by the submerged mind. The somnambulist, however, keeps a fairly normal sense of touch and balance. He deftly steps around a chair or coffee table and other objects in the room, and he avoids fences and other obstacles outside. He seems to know just where he is going on his nocturnal journey.

The wandering soldier at Camp Lee, according to Army psychiatrists, was out on a definite search. The uncle he was looking for had taken care of him as an orphan. This memory in his subconscious sent him out seeking the only family love he had ever known.

Hopes, fears, desires, worries, all stored deep within the mind, are among the remote causes that can trigger sleepwalking. Physicians also speak of more immediate causes: blood-and-thunder television shows, spine-chilling stories, or disturbing experiences that occur shortly before you go to bed.

Who are they? Sleepwalkers are usually active persons; for the most part, they are in good physical health. A study by Navy doctors showed that somnambulists were chiefly of average or high intelligence. Other studies, too, reveal that sleepwalkers are usually well adjusted on the surface. But underneath they

may be hiding strong yearnings and conflicts.

The West Virginian collegian, for example, did not really want to study law, as he was doing; he was being pushed into it by his parents. He dreamed, instead, of the life of a highway contractor.

A New Jersey textbook salesman was found one night starting to climb upward from his sixth-floor apartment window. Later he explained to friends, "I guess I always admired mountain climbers."

Unseeing eyes. Although a sleepwalker is "out of this world," he gives the appearance of being awake. His eyes are open, but he does not "see" in the usual sense. If you

[Continued on page 216]

Mechanics and Handicraft SECTION

**Here's an exciting breakthrough
in the art of free-flight models**

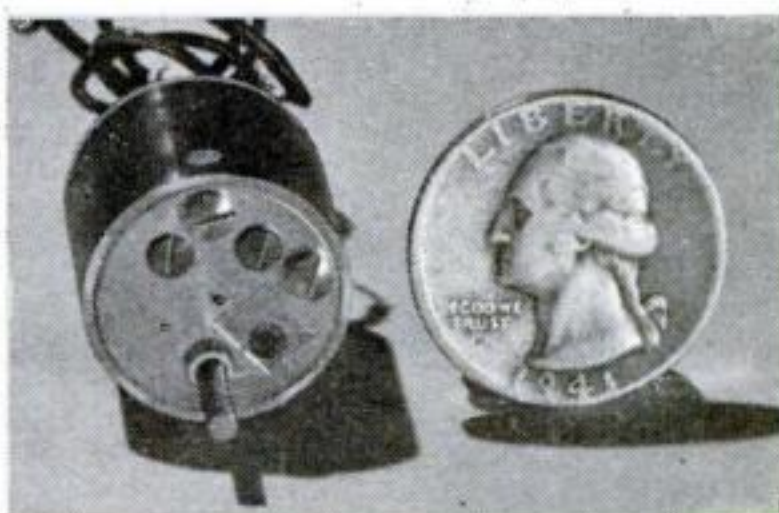
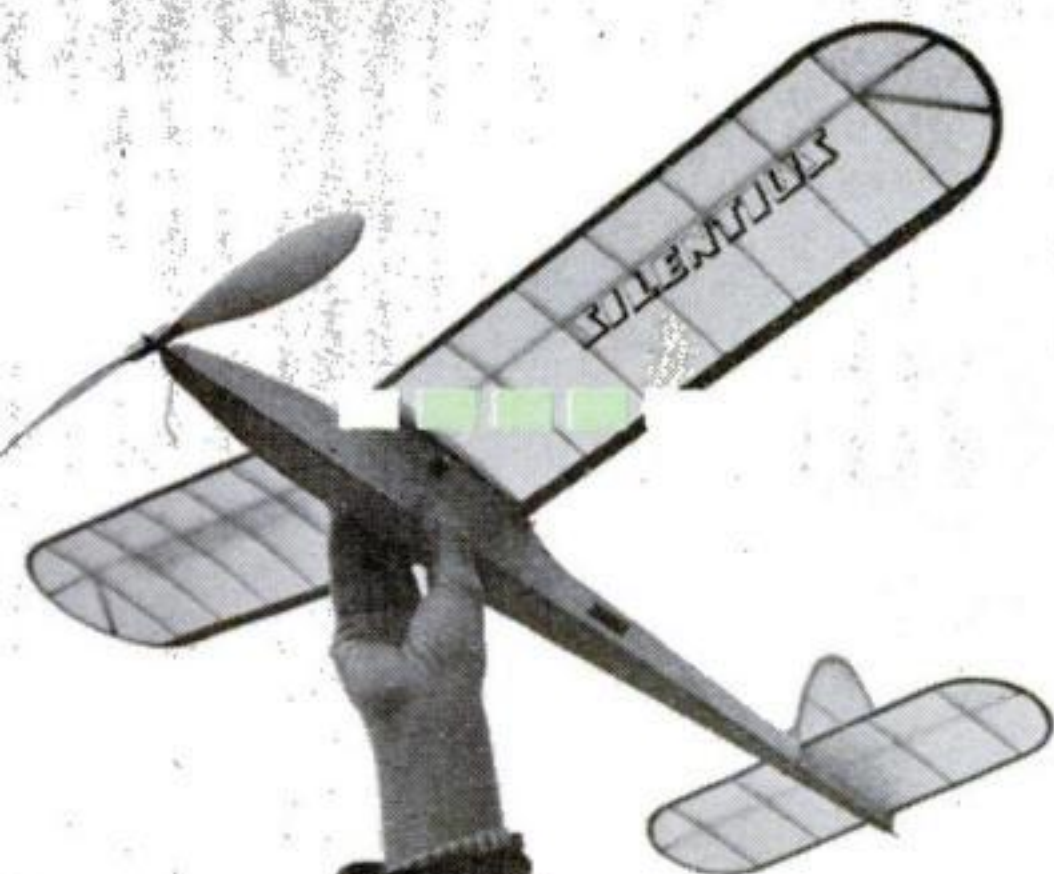
Flying the New Electric-Prop Planes

**By
Howard
McEntee**

THERE'S a new thrill in store for pilots of free-flight model planes—the new electric-motor jobs. The motors are tiny jewels, smaller in diameter than a quarter. Penlight cells run them.

The motors are sold for use with two imported model-plane kits, one from Germany and one from

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About the Author

Howard McEntee, one of the foremost authorities on model airplanes, was the logical choice to test-fly the exciting new electrics for **POPULAR SCIENCE**. A former editor of *Model Airplane News*, he parlayed a childhood knack for folding paper airplanes into a 40-year career as an expert on all types of model planes. When he isn't flying them at his Ridgewood, N. J., proving grounds, he's writing about them as Radio Control Editor of *American Modeler*. The most popular of his several books, *Radio Control Handbook*, is considered the bible of its field.



Japan. The planes are gauzy frame-and-tissue affairs, designed for low weight, with big gliderlike wings for high lift.

A new challenge in skill. Gas-prop planes have enough excess power to overcome sloppy construction; electric planes don't. Their much lower prop torque demands an absolute minimum of weight and a maximum of lift. This calls for real model-building skill—the same skill you needed years ago to build a successful rubber-band model.

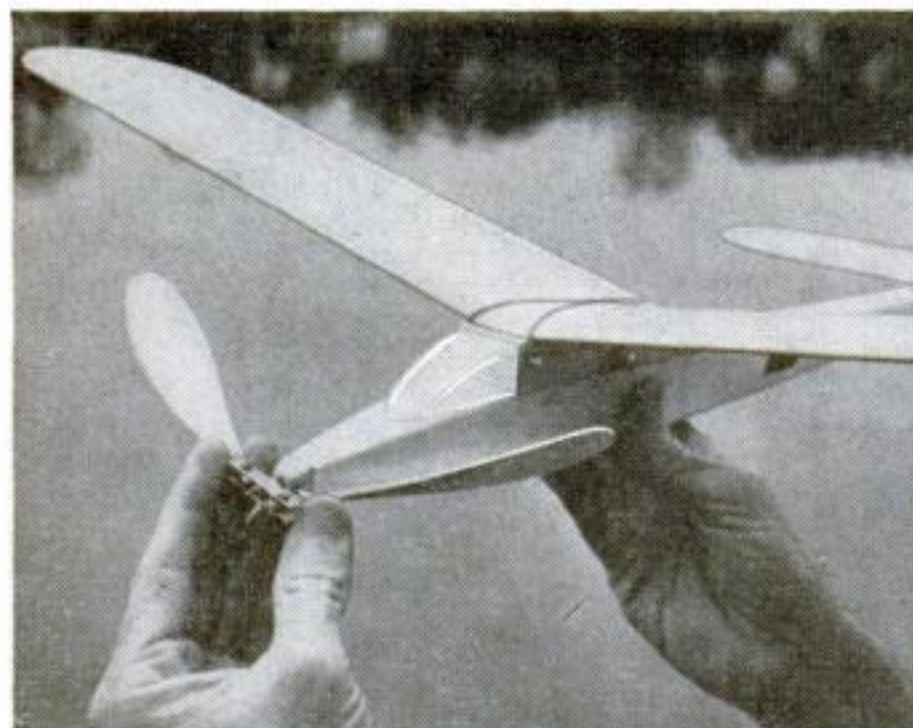
Cement must be used sparingly to save weight; wings must be pinned flat during assembly to prevent power-robbing warps; the tissue covering must be free of lift-killing wrinkles. You may even want to forego the usual gleaming—and heavy—paint job.

Flight techniques also represent a return to the challenge of rubber-band days. Because the batteries last only a short time under constant drain, the

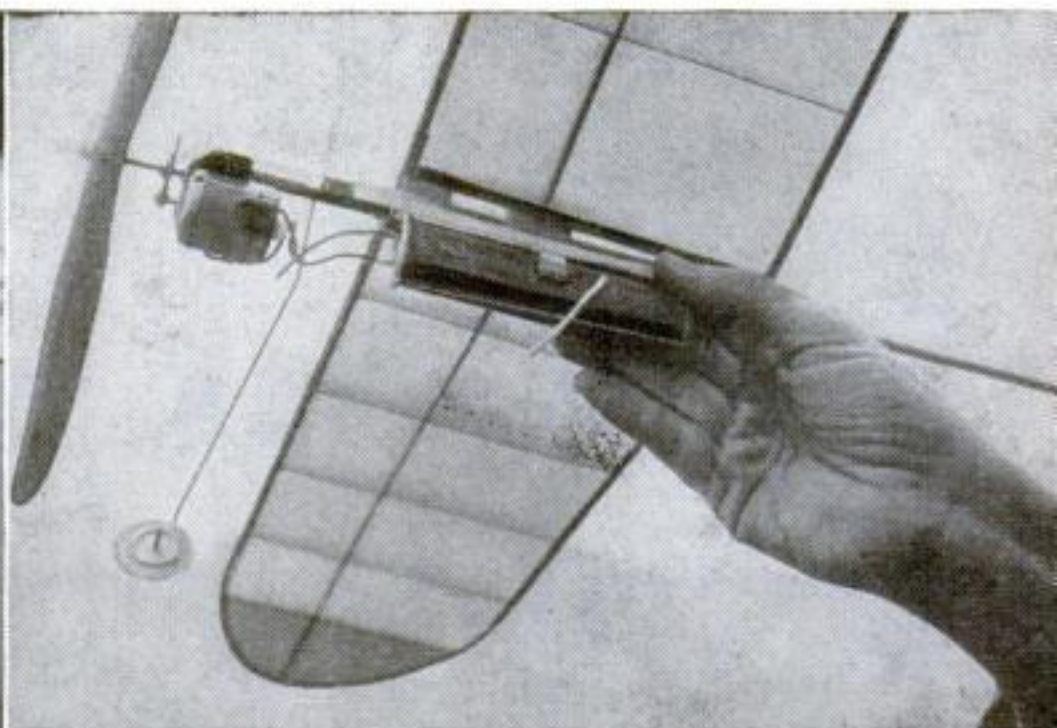
objective is to get the plane to a high altitude and then cut the motor with a timed fuse. The prop then folds or disengages and the plane returns to earth in a flat, graceful glide—actually a longer powerless flight than the original climb.

The power plants. The tiny motors require only about four volts and weigh less than an ounce in the case of the German model and about 1½ ounces for the Jap one. Their high-speed rotors, spinning up to 18,000 r.p.m., are geared down through miniature watchlike power trains to drive big-bladed propellers. The midget motors have been made possible only since the war—with the development of more powerful batteries and permanent-magnet motors that eliminate bulky field coils.

The German motor, called the Mikro-max T 03/15, has a 15:1 reduction and drives a whopping 12¾"-long prop at about 1,200 r.p.m. Its design is unusual.

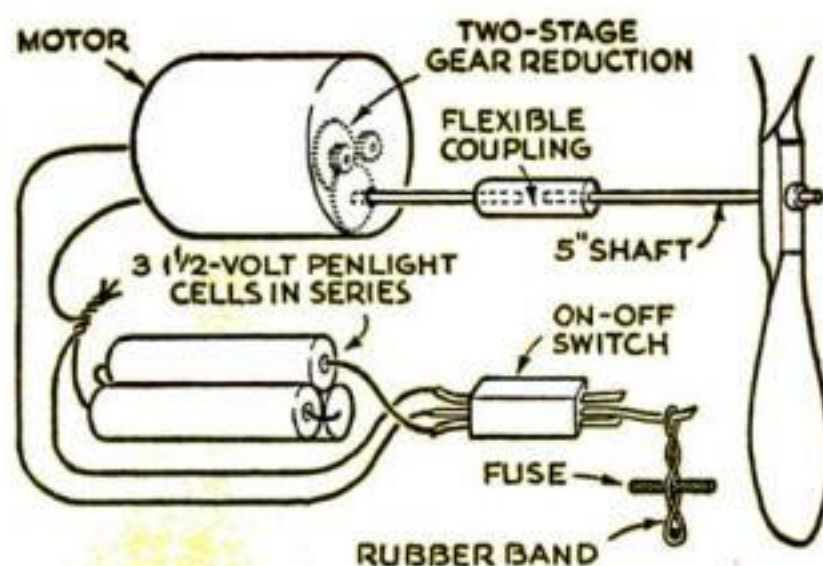
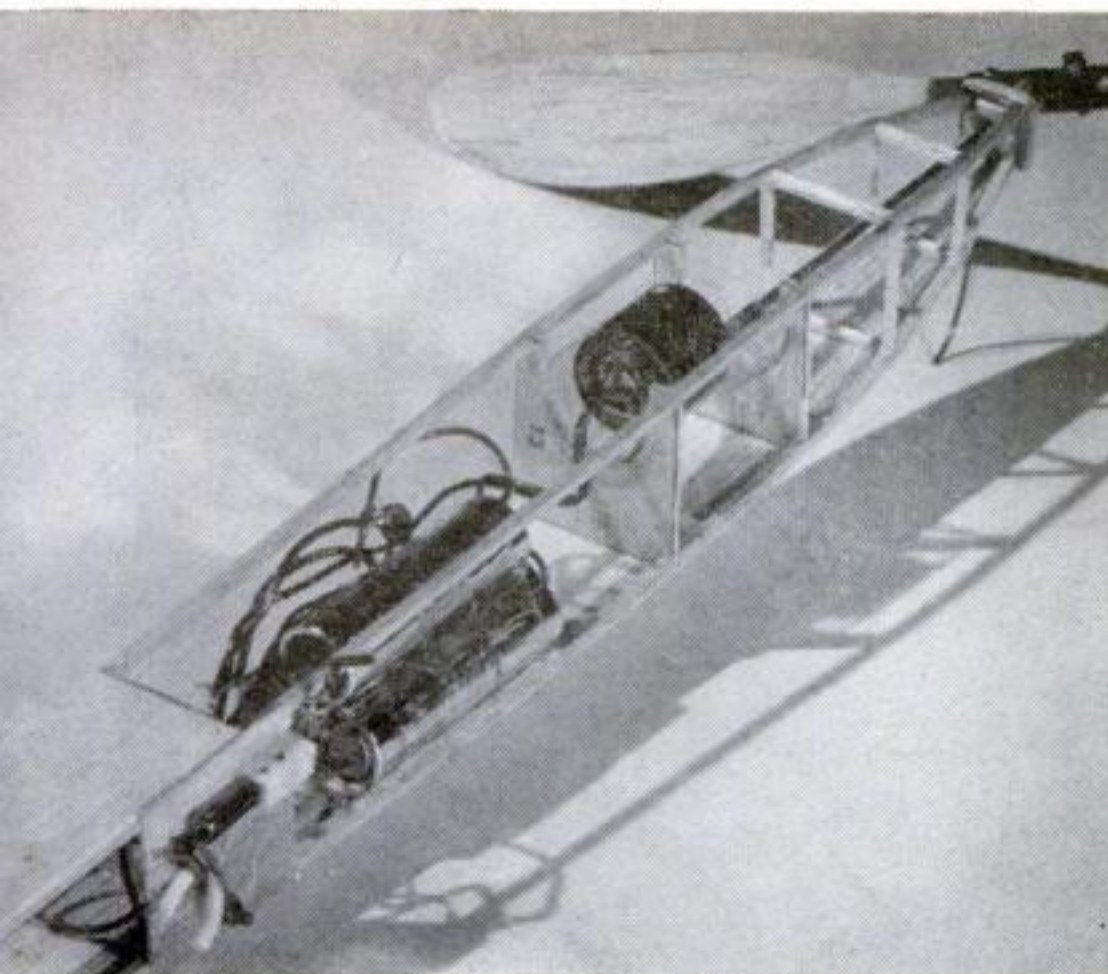


HINGED PROP BLADES fold flat against the fuselage of this German model as soon as power is cut so that the plane will glide freely without wind resistance. The trim fuselage, plastic canopy, and large wings give the five-ounce ship a graceful, gliderlike appearance.

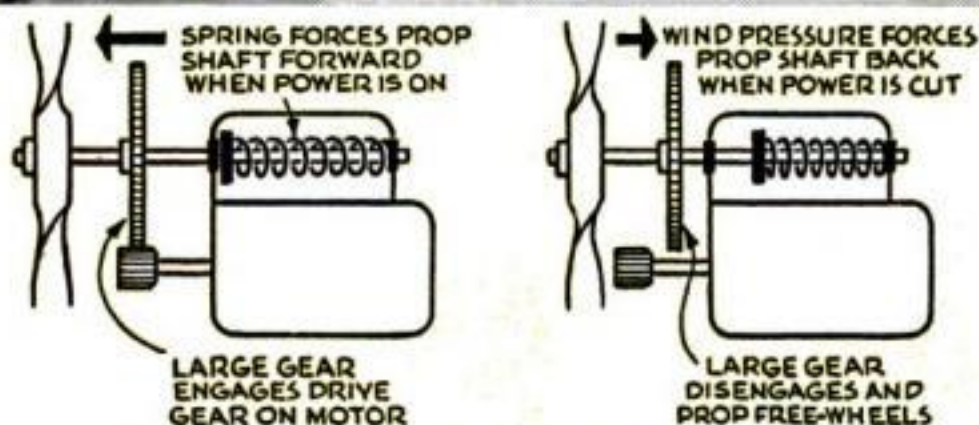


SLIM, STICK-TYPE "FUSELAGE" on the Jap-made model is designed to save weight. Fuse inserted in a rubber band on the battery case opens the switch to cut power after a preset time. Note single nose wheel to protect prop on landings, replacing heavier conventional gear.

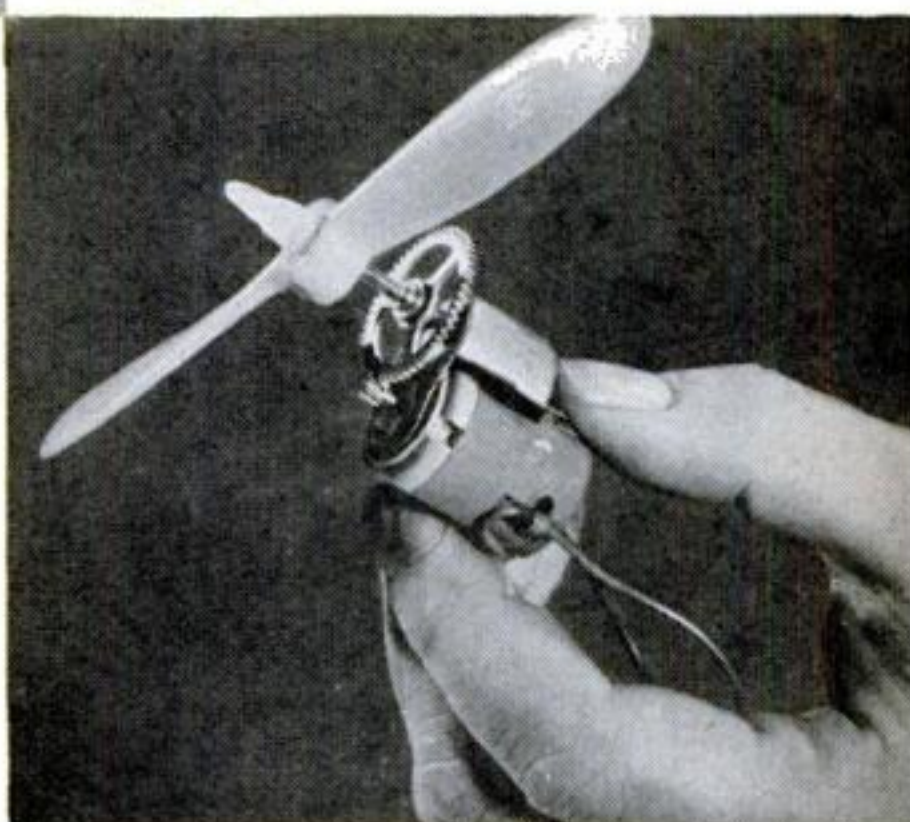
Tiny, ingeniously complicated power plants drive the models



LONG DRIVE SHAFT connects prop to motor in German model. Note the simple flexible coupling—just a length of rubber tubing—for smooth starts. Watch-size gears, shown in sketch above, are hidden inside motor housing, drive prop at a 15:1 reduction. Motor switch, on outside of fuselage, is held closed by a fused rubber band.



SINGLE LARGE GEAR on a countershaft above the Jap motor drives the prop at about 7:1 reduction. Countershaft is spring-loaded, as shown above, so prop shaft engages drive gear when power is on. When power is cut, wind pressure forces the prop back against the spring so it disengages the drive gear. Prop then free-wheels so plane will glide without drag.



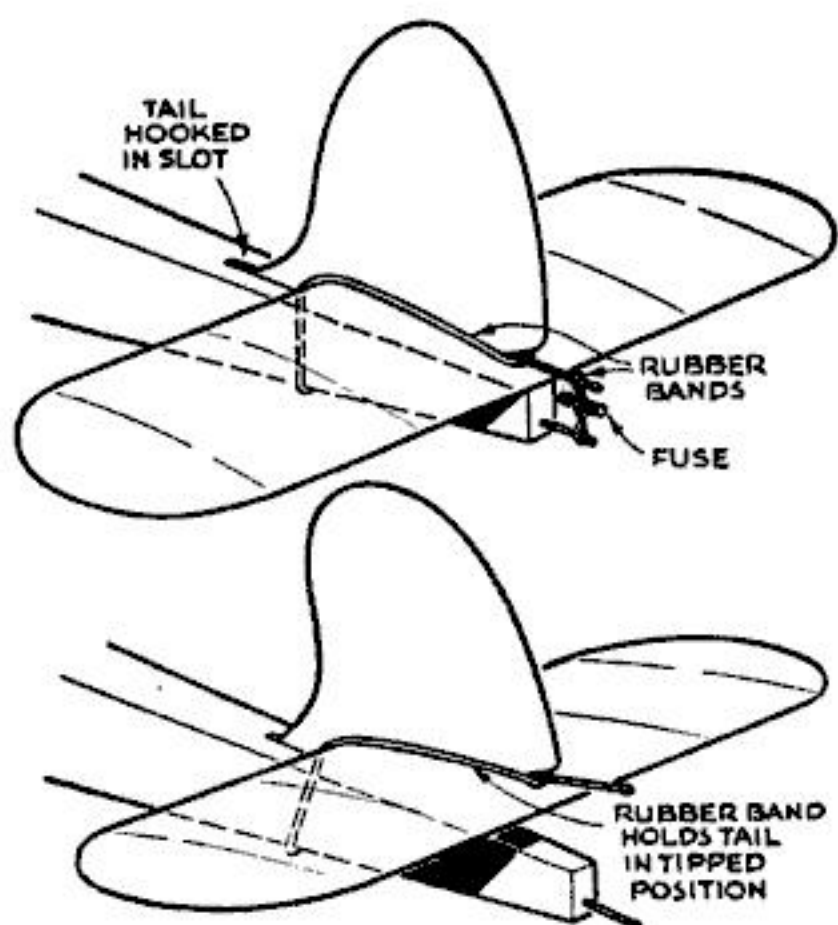
The permanent magnet is located *inside* the armature windings in place of an iron core. The outer casing is an iron core that completes the path for the magnet. The motor has such other exotic features as a silver commutator and gold-alloy brushes. It's said to have an efficiency of 75 percent without gears—an astonishing figure. A clever flexible coupling between the motor shaft and the prop shaft enables the motor to take up the load without shock.

The Jap motor, called the AP-35, has a gear reduction of about 7:1 and spins a shorter 9 1/2" prop a little faster, at about 1,500 r.p.m. It's somewhat less powerful than the German motor, but it has sturdy bronze bearings and modern ceramic magnets.

The motors do not come with the model-plane kits and must be bought separately. It's important to get the right one for each model as there are other miniature power plants made for different purposes. In some cases, the propeller must also be bought extra.

What the planes are like. The German model, called Silentius, has a wingspan of 30" and weighs less than five ounces, including power plant. It's the fancier of the two, having a true fuselage with a trim, gliderlike appearance. Total cost for the kit, motor, and prop is about \$15.

The Jap model, known as the TK-1, is bigger, with a 38" wingspan, but has a more primitive sticklike fuselage reminiscent of early rubber-band models. This, however, makes it considerably cheaper



HOW "DETHERMALIZER" WORKS: Tail on German plane is held down by a fused rubber band, as at top above. When the fuse burns through the rubber band, the tail pops up, as at bottom. This quickly destroys the plane's ability to climb, bringing it safely back to earth.

—less than \$6 including motor—and also simplifies assembly. It weighs about 6¾ ounces ready to fly.

The parts in the Jap kit are already cut out for you; those in the German kit aren't. Both kits come with complete instructions in English.

Electric power vs. gas. The new planes are no competition for glow-plug models and aren't intended to be. They have their own special charms. They're not temperamental; they start instantly in any weather. They fly as soundlessly as the breeze, never run out of fuel, and eliminate the fire hazard of working with hot fuels. Their flight is leisurely and enjoyable; you don't spin yourself dizzy on the end of a control line. When a mishap does occur, they don't screw themselves into the ground with the ferocity of a gas-prop job.

The safe and quiet operation of electric models is opening up new possibilities for model-plane sport in communities that frown on the gas-engine types. Their gentle nature permits meets to be held in gyms and armories without dependence on fair weather.

On the minus side, the planes require some pampering. They do not have enough power for ROG (rise-off-ground)

takeoffs; you must launch them by hand. They also require calm air to fly successfully—"electric-flight weather," as hobbyists have dubbed it. Because the batteries run down so quickly, you're restricted to fairly short power-on periods—about 20 to 30 seconds—if you want the cells to last. The motors may also heat up and become damaged if they're allowed to run too long.

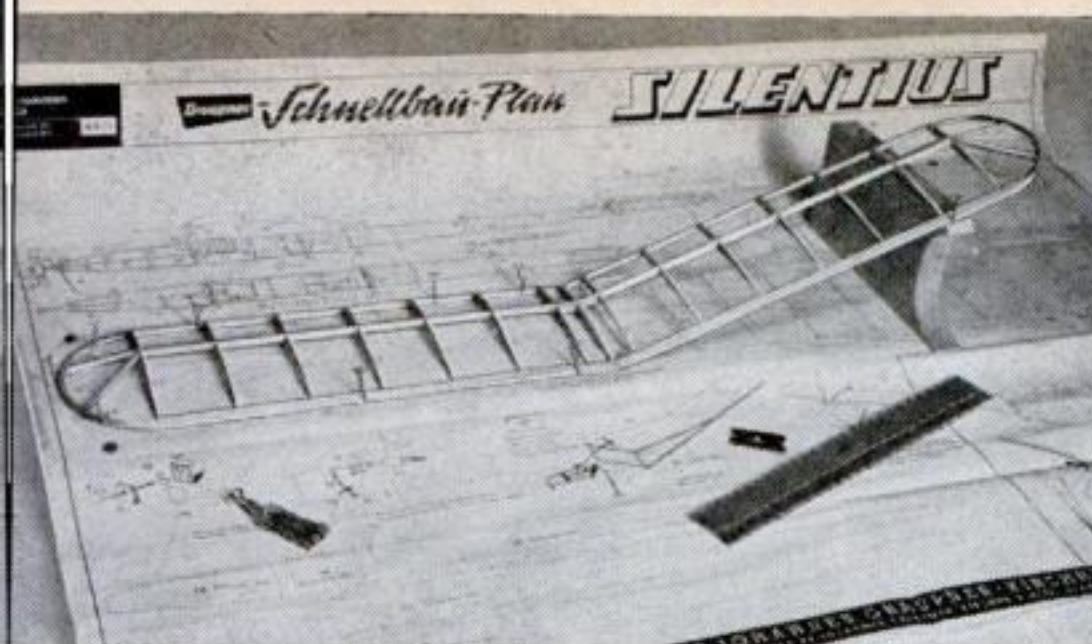
The German plane has a climbing rate of three feet a second, which its designer, Fred Militky, says is "not spectacular" compared to what future developments in electric power will bring. Still, it seems adequate enough considering that Militky's first successful model flew clear away after climbing for five minutes. Militky, incidentally, tried more than 250 different designs over an 18-year period before finally coming up with a reliable model.

How power is controlled. The shut-off switches in both planes are held in the On position by a rubber band with a short fuse inserted in it. When the fuse burns down, it melts the rubber band and releases the switch, shutting off the motor.

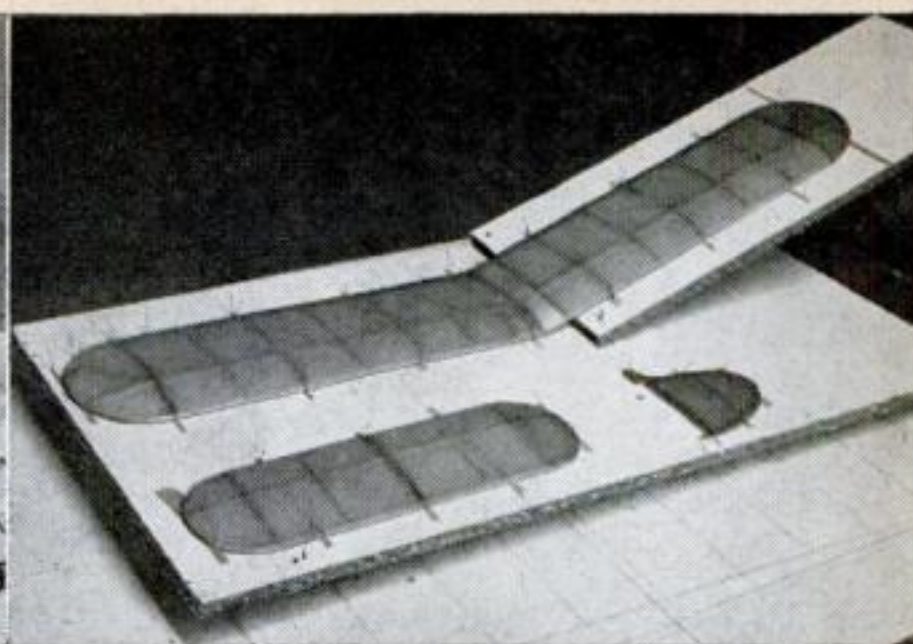
The German plane uses a second fuse to operate a "dethermalizer." This is designed to keep the lightweight plane from being swept aloft by rising thermal air currents and becoming lost. The entire tail section is pivoted and is held down by a fused rubber band. When the fuse burns through the rubber band, the tail pops up at a steep angle. This destroys the plane's ability to climb, but without making it crash. It descends rapidly but gently, something like a parachute.

Fuses are included in both kits, and the length you use determines how long the power stays on. On one of the models shown here, a miniature pneumatic timer (Elmic Mini-Diesel, available at hobby shops) was used in place of the fuse arrangement. This adds a little extra weight, but is handier to use and more reliable than the fuses. The dethermalizer is usually needed only on very hot days or when you're trying to break altitude records.

Getting long, graceful glides. Both power plants have ingenious devices for reducing the drag of the prop after power has been shut off, so the planes will glide freely.



WINGS ARE THE TRICKIEST to assemble, must be absolutely true for good lift. To insure perfect alignment, parts are pinned down over plans supplied in the kits until glue sets, as



above at left. Gauge block establishes correct dihedral angle. At right, wings and tail are also pinned flat after tissue is applied to prevent warps as the covering shrinks.

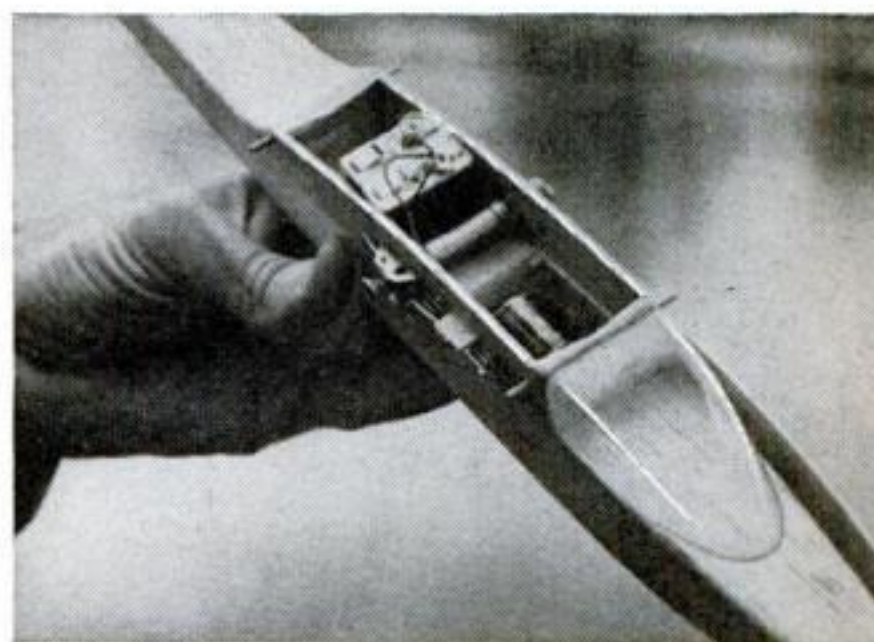
The giant German prop is a "folder"—its blades, pivoted at the hub, automatically swing back against the fuselage when power is cut so they offer less wind resistance. When the switch shuts off, it also shorts out the motor, stopping it immediately without any over-run. This gets the prop stopped and folded instantly for an unrestricted glide.

The Jap motor has a disengaging device that allows the prop to freewheel during a glide. The prop is spring-loaded so that it engages the drive gear during powered flight. When power is cut, wind pressure overcomes the spring, disengaging the prop and permitting it to spin freely without resistance.

What kind of batteries? Both planes will run satisfactorily on ordinary $1\frac{1}{2}$ -volt penlight cells. The German one uses three, wired in series, for a total of $4\frac{1}{2}$ volts. The Jap model uses four cells in series to get six volts. In tests, the German motor drew 1.6 amps and the Jap 1.7 amps—a remarkably high drain to impose on tiny flashlight batteries.

Because of the high drain, several other types of batteries are recommended for longer life. Photoflash batteries in the penlight size will deliver high power in short bursts for brief flights. Still more durable are the newer alkaline cells, such as Eveready's E-91. These cost somewhat more than standard cells, but will give many times more flights.

The German plane, with more cockpit space, is designed to take another type of special battery. This is a lead-acid cell called Rulag RL-4, made for use in electric cigarette lighters. It costs about



ROOMY "COCKPIT" in German plane can hold cigarette-lighter batteries instead of penlight cells for greater power. Tiny pneumatic timer on fuselage was added by the author to make power control more precise than with fuses.

75 cents and is available at large cigar, jewelry, and department stores. Two Rulag RL-4s weigh $1\frac{3}{4}$ ounces and will provide 10 to 15 flights lasting about 20 seconds each.

Although the Rulag cells are not intended to be recharged, they actually can be charged a limited number of times in order to cut cost. Instructions for recharging come with the German kit. The Jap plane's battery holder is designed to take only penlight cells, so a special holder would have to be devised to carry the Rulags.

The kits can be obtained at many local hobby shops or from Polk's Model Craft Hobbies, 314 Fifth Ave., NYC. Other sources are Wilshire Model Center, 1326 Wilshire Blvd., Santa Monica, Calif., for the German plane, and Associated Hobby Mfrs. Co., 413 East Allegheny Ave., Philadelphia, for the Japanese model.



**Now...
another**

BIG BONUS for readers

A NEW value-packed PS editorial feature begins on the facing page, the Save-It Section, a handy package of shop reference material. Lift it out of the magazine. File it away.

Other Save-It Sections will appear from time to time in future months, each with useful information packed into full-size pages that you can file away with the rest of your PS reference material. These Sections take their place beside other notable POPULAR SCIENCE firsts—the Bonus Booklets, the free Foldout Blueprints, and the regular tear-out departments that you can combine into your own home-repair manual: Fix-It File, Know-How File, Materials File.

The Save-It Section that follows consists of two sheets, each folded in the middle.

To remove the Section, pinch it together and carefully lift the end that's toward you, pulling gently but steadily to free it from the first staple through the magazine. (This will rip a small section from the fold, but you'll take care of this later.) Still lifting firmly, tear the Section free from the second staple—and the magazine. Finally, to make your Section a permanent addition to your shop reference material, staple it through the edges and, if desired, crease a strip of tape along this edge. Masking tape is fine for this. It won't peel off with time.



**Facts at your fingertips
about simple power
transmissions for
house, workshop, and
garden equipment**



Belts and Their Drives

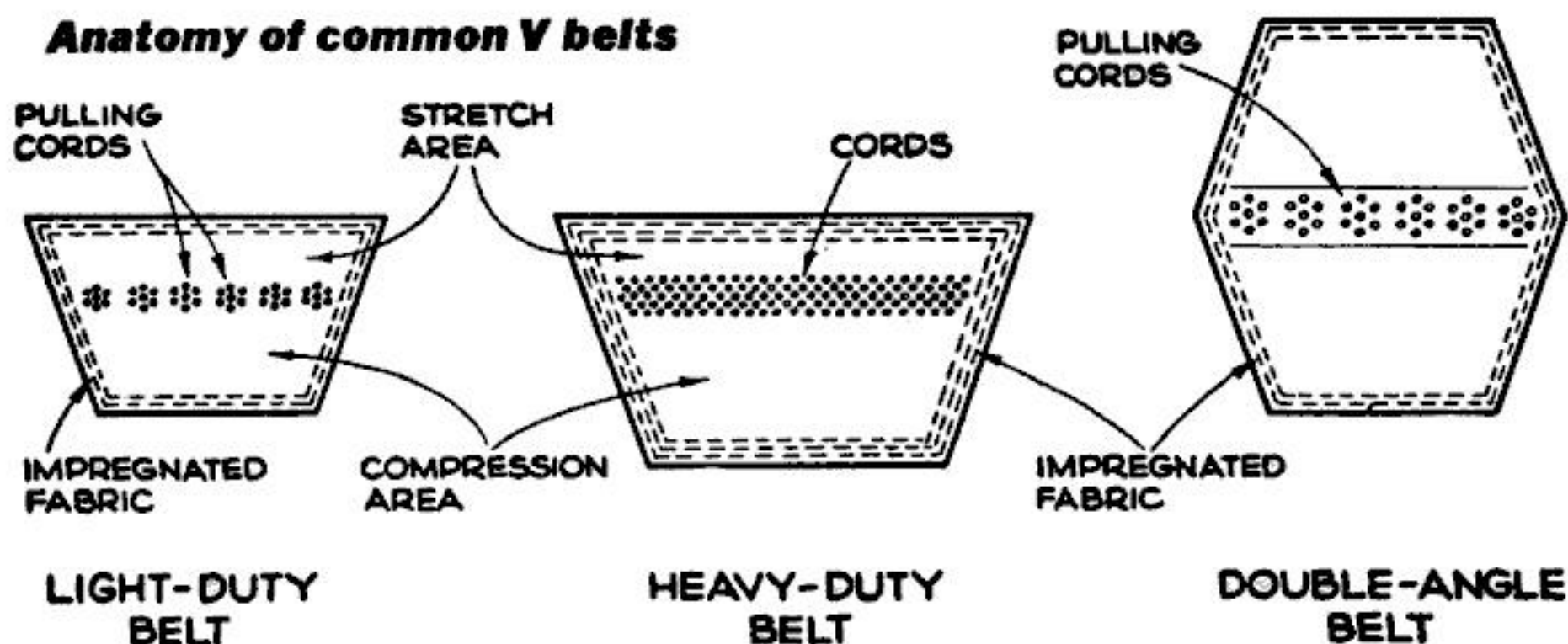
EVEN automobiles can't do without V belts. Small wonder they're humming in the workshop, in home appliances, pumps, heating and cooling equipment, and powered garden tools.

If you're setting up a power tool or building any motorized mechanism, you're likely to use a V belt somewhere. These fabric-and-rubber sinews are the simplest means of transmitting power from one shaft to another, besides offering easy means to brake, clutch, and even shift drive ratios.

Because of its thickness, a V belt going around a pulley has to stretch on the outside, squeeze together along the inside, and sustain a hefty pull in between. This

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Anatomy of common V belts



pull, which carries the load, is taken by tough cords sealed into the belt carcass between the stretch and compression areas.

How they grip. Thanks to the wedging action of their angled sides, V belts pull well even when wet. The section going around a pulley tends to bulge as it's bent, thus hugging the flanges tightly. Pinch the sides of a V belt hard with two fingers, bend it sharply with the other hand, and you can feel it flex its rubber muscles.

The angle between belt sides is 40 degrees; that between the two sides of the pulley (or sheave) groove is somewhat less to insure full wedging contact. The groove is much deeper than the belt, for a V belt must never ride the bottom of the groove. If it does, it loses almost all traction, no matter how taut.

Reading belt sizes. The commonest V belts are the $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{5}{8}$ " widths. But you'll rarely find these fractions on a

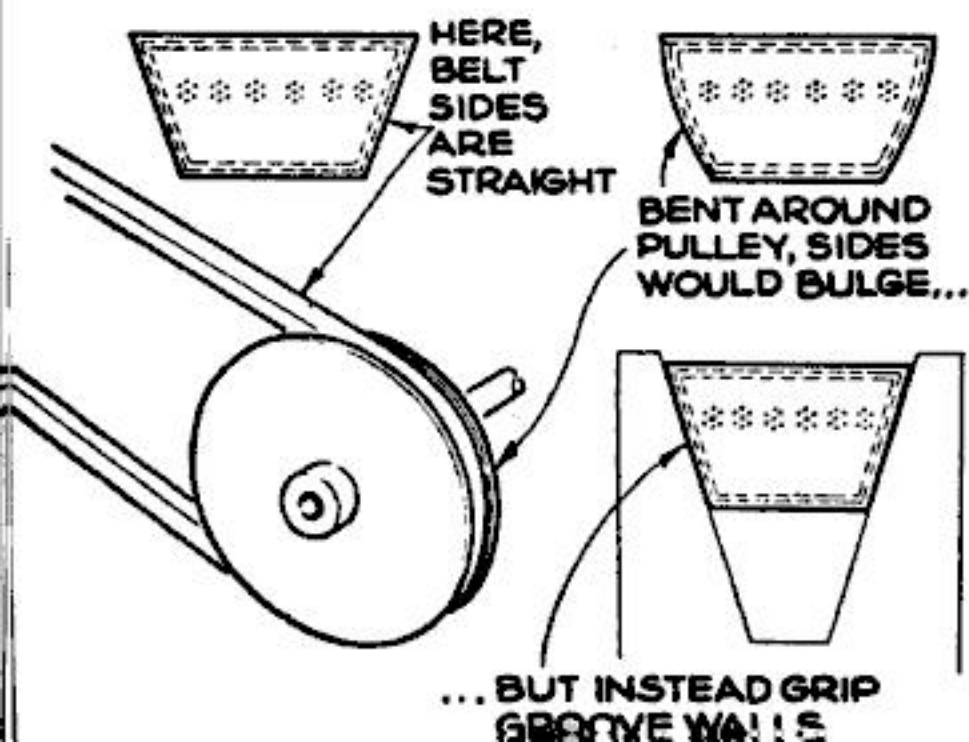
belt. Markings usually show the width, duty type, and length in a simple code, but the code varies among manufacturers. In a typical marking such as 3L405, for example, the 3 stands for $\frac{3}{8}$ " nominal width, the L for light duty, and the next three digits for belt length in inches—the last one in tenths of an inch (usually zero, meaning no fraction; or 5, for $\frac{1}{2}$ "). The 3L405 belt is therefore $40\frac{1}{2}$ " long.

The letters O, A, B, and figures 2, 3, 4 are also used for $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{5}{8}$ " belt sections, sometimes indicating greater duty capacity than the L type in those same sizes. But load-rating designations are not standardized. Though sometimes called fractional-horsepower sizes, these belts under proper conditions can transmit several horsepower.

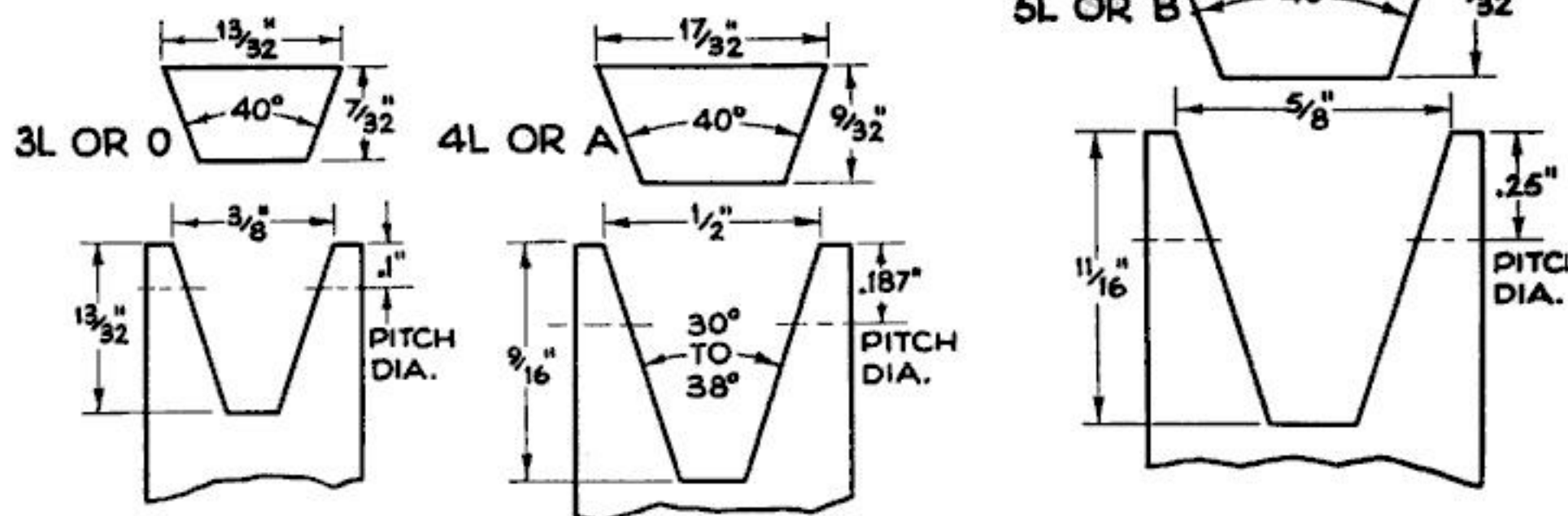
Pitch diameter and length. Since a V belt has a definite thickness, what contact diameters on the pulleys should be used in figuring ratios? To calculate these and shaft spacing exactly, engineers use what they call the pitch diameter—the theoretical line at which the belt and sheave flanges travel together without any slippage. An accompanying table shows how much to deduct from outside pulley diameter to find pitch diameter.

Since pitch diameter lies inside the sheave rim, belt measurement around this line will be shorter than around the outside diameter. For accurate calculations, the difference is deducted from outside belt circumference as shown in another table. But belt markings usually give the outside length. (Exceptions are the markings on Dayton, Manhattan, and Browning V belts, which indicate inside length instead.)

How a V belt grips



Belt and sheave-groove dimensions



THE V-BELT ANGLE is always 40 degrees, but groove angles vary with the size of the sheave, as in table at right. Should you machine your own pulleys, round off outer groove corners with a file. Finish the groove faces smoothly to avoid rapid belt wear, but don't round them.

Included Groove Angle of Sheaves

PITCH DIAMETER	3L Belt	4L Belt	5L Belt	Groove Angle
to $1\frac{1}{4}$ "	to $2\frac{3}{8}$ "	to $4\frac{3}{8}$ "	to $5\frac{3}{8}$ "	30° - 32°
to $2\frac{3}{8}$ "	to $3\frac{1}{8}$ "	to $4\frac{3}{8}$ "	to $5\frac{3}{8}$ "	32° - 34°
to $3\frac{1}{8}$ "	to $4\frac{3}{8}$ "	to $5\frac{3}{8}$ "	to $7\frac{1}{8}$ "	34° - 36°
$3\frac{1}{8}$ " and up	$4\frac{3}{8}$ " and up	$5\frac{3}{8}$ " and up	$7\frac{1}{8}$ " and up	36° - 38°

To buy a replacement, you can use the figures on the old belt. If they're not legible, don't measure the belt—it will have stretched. Pull a steel tape around the outside of the two pulleys, first slackening off the tensioning adjustment to one quarter of its take-up distance. You'll need the remaining three-quarters to take up the initial stretch of a new belt, and a little more from time to time, for V belts get longer—never shorter—in use.

Never buy a belt so tight that it has to be pried over the sheaves. This breaks the pulling cords inside. And buy the belt to suit the job. Among the special kinds:

- Heavy-service belts come with rayon, nylon, and even steel pulling cords. They can handle more power and run with greater tension than light-duty belts. They won't bend as sharply, of course, as lighter ones, and are more readily damaged if run on undersize pulleys.

- Narrow V belts are now familiar because of their use in modern cars. They're designed for high tension, high power transfer, and compactness—their narrow sheaves save on tight engine clearances.

- Open-end belts may be used where the common, closed V belt cannot be installed. The ends have metal fasteners joined by a pin, or a link and two pins.

- Cog belts have teeth on the inside,

although used on plain pulleys. The notches between the teeth enable these belts to flex over smaller sheaves, making possible shorter centers and more compact drives. In some cog belts the teeth have flat bottoms for running efficiently in V-flat drives.

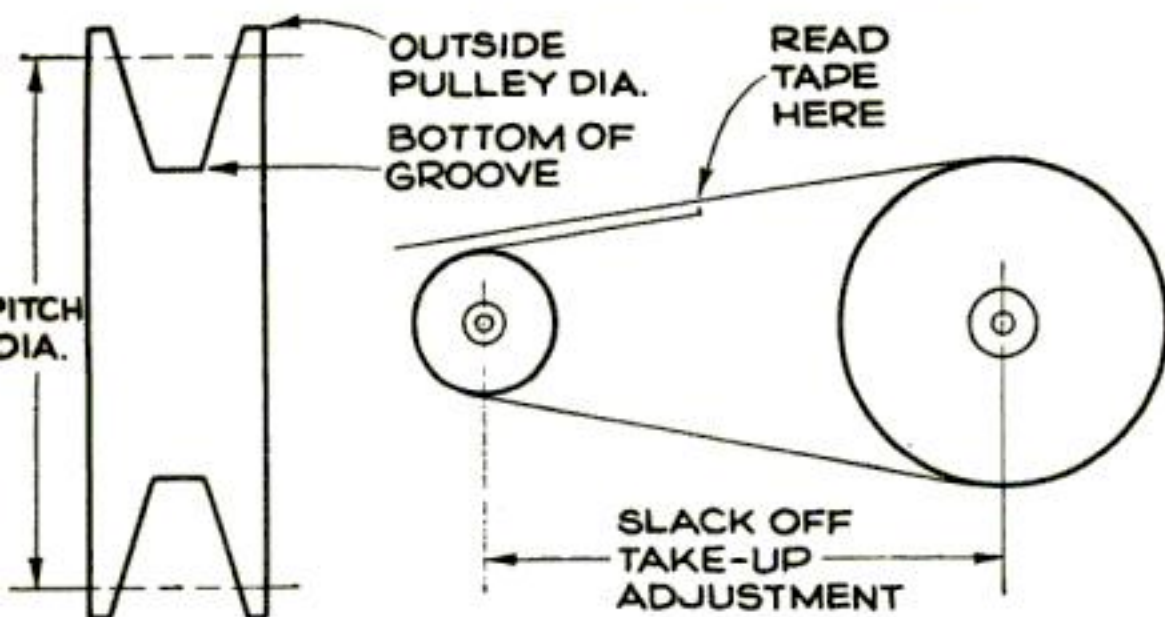
- Double V belts, hexagonal in cross section with the pulling cords in the middle, are designed to ride pulleys on both sides. A single serpentine drive with a double V belt can power several parallel shafts and even reverse rotation of one or more.

Types of V drives. Commonest is the reduction drive, in which the power source turns faster than the driven shaft. Less common are these:

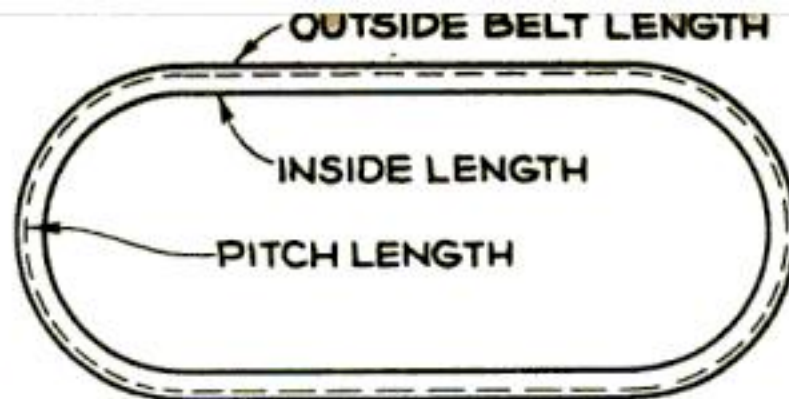
- The speed-up drive, where the load must run faster than the motor or engine, is considered harder on belts; manufacturers recommend figuring the drive with a little extra capacity. Circular saws are an example.

- The V-flat drive is a reduction drive with a V pulley on the motor and a flat one on the driven shaft. It's used in industry and on some lathe countershafts. To be effective, a V-flat drive should have a big ratio and short shaft spacing, to allow plenty of wrap-around on the sheave. The sheave should have a perfectly flat face—not a crowned one.

Pitch diameter and pitch length



PITCH DIAMETER, reckoned as that on which the belt tracks without slippage, lies inside the groove. To use it for precise ratio calculations, deduct measurement in the table at right from the outside pulley diameter. To find pitch length along line that rides pitch diameter, deduct amount given from the outside belt length. A rough measurement for replacement belts can be made by pulling a steel tape around the pulleys as in the diagram above.



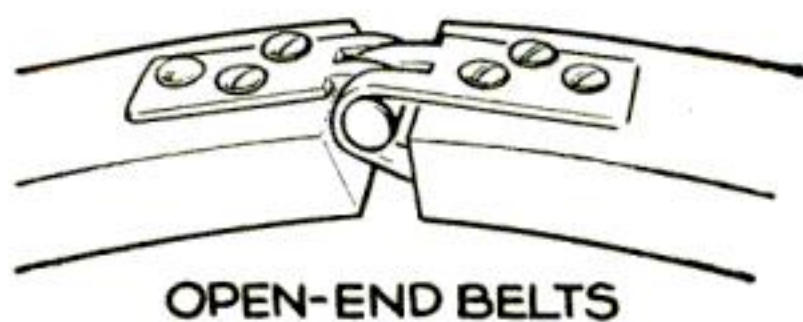
Pitch Deductions

Belt Size	Belt Pitch Length	Pulley Pitch Dia.
3L or O	.7"	.20"
4L or A	1.0"	.375"
5L or B	1.2"	.5"

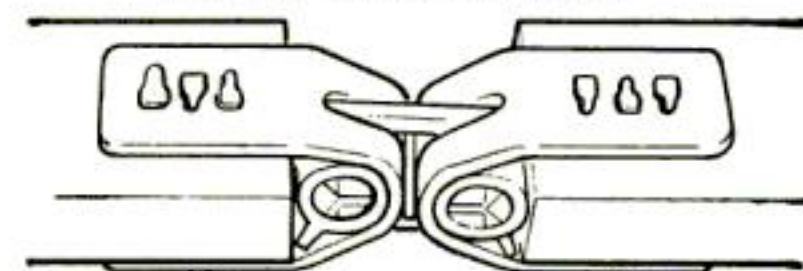
Minimum Pulley Sizes

Belt Size	Recommended Minimum Pitch Dia.	Absolute Minimum Pitch Dia.
3L or O	2.5"	1.5"
4L or A	3.0"	1.8"
5L or B	4.0"	3.0"

Special types of V belts



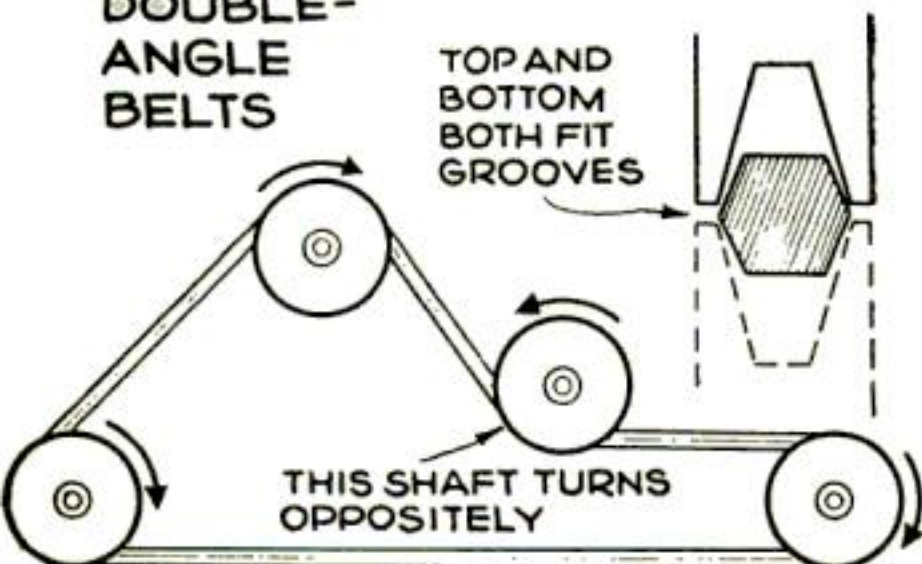
OPEN-END BELTS



COG BELTS

COGS CLOSE UP AS BELT BENDS

DOUBLE-ANGLE BELTS



TOP AND BOTTOM BOTH FIT GROOVES

THIS SHAFT TURNS OPPOSITELY

- Quarter-turn drives (used on early rotary mowers to drive the vertical blade shaft from a horizontal-shaft engine) twist the belt through 90 degrees. Deep-groove pulleys should be used, and the shafts offset to bring the taut or pulling side of the belt more parallel to the groove at the smaller sheave. Mount the belt so that the tight side is at the bottom—so minimizing the sag that tends to pull it off the sheaves—and count on only 75 percent of the power capacity of a normal drive with the same belt-speed-sheave combination.

- Idler-angle drives between horizontal and vertical, or otherwise angled, shafts (from a bench-mounted motor to a drill-press spindle, for instance) subject the belt to two 90-degree twists. Distances from the idlers to both shafts should be generous. Deep-groove idlers should be used, as the makers of one popular compact car discovered after its fan belt persistently rode itself ragged in shallow ones.

- Dual and multi drives. Two 3L belts can transmit more power than a single 5L belt where shaft spacing and pulley sizes are limited. Some 10" circular saws have dual belt drives; industrial machines may have multigrooved pulleys

with several ganged V belts. Belts pulling together should be matched—of the same make and length, or bought as a matched set—and replaced as a group, never singly.

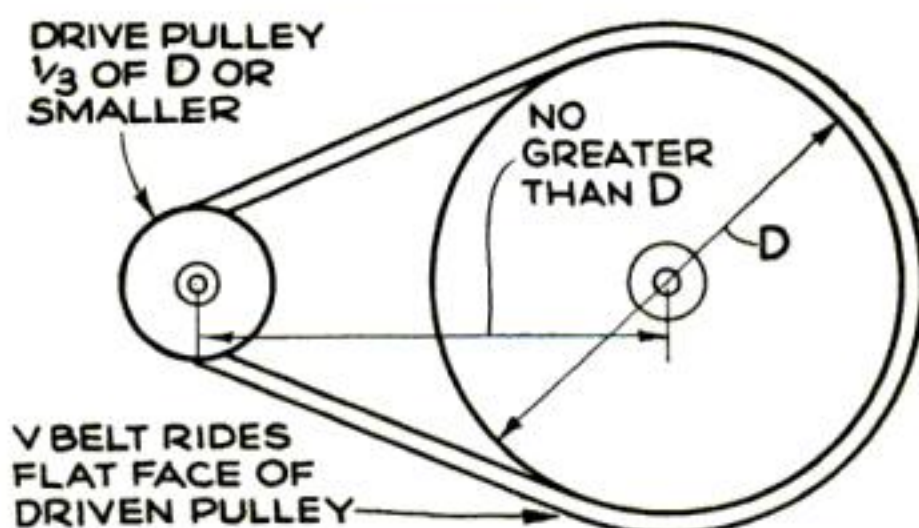
Figuring your own drive. Rule One for full power capacity is to use the largest pulleys feasible. At 2,000 r.p.m., a 3 L belt on a 3" sheave can transmit about $\frac{3}{4}$ hp., but on a $1\frac{1}{2}$ " pulley less than $\frac{1}{4}$ hp. Too-small sheaves also cause excessive belt flexing and quick wear, especially at high speeds. This consideration usually limits ratios, and often requires a two-step drive. (Remember that the overall ratio of two steps is found by multiplying, not adding the individual ratios. Thus if one step is $2\frac{1}{2}$:1 and the other 3:1, the overall is $7\frac{1}{2}$:1.)

Figure each step separately. Choose pulley sizes to obtain the desired ratio and fit available space. Then multiply the diameter of either pulley by its speed, and multiply the result by .262.

This gives the surface speed of the belt in feet per minute. If it's more than 4,000 for small belts or 5,000 for $\frac{1}{2}$ " and $\frac{5}{8}$ " belts, try figuring with smaller pulleys that give the same ratio. This is a necessary compromise despite the lower efficiency of smaller sheaves, for at excessive surface speeds, centrifugal force tends to throw the belt out of the sheave grooves.

Now check belt speed and the diameter of the smaller pulley against the horsepower-rating table to find the load capacity of the drive. The figures given are

V belts on flat sheaves



COMPACT DRIVE at right for 3:1 and higher ratios uses a flat-faced large pulley. It may be single-, dual-, or multi-belted. Ideal arc of contact on big pulley is 240 to 250 degrees.

for light-duty belts. The heavier-duty types will transmit considerably more power, especially at the higher speeds. Note that there is a power crest for any belt-and-pulley combination at a certain surface speed. Capacity is smaller at both lower and higher speeds.

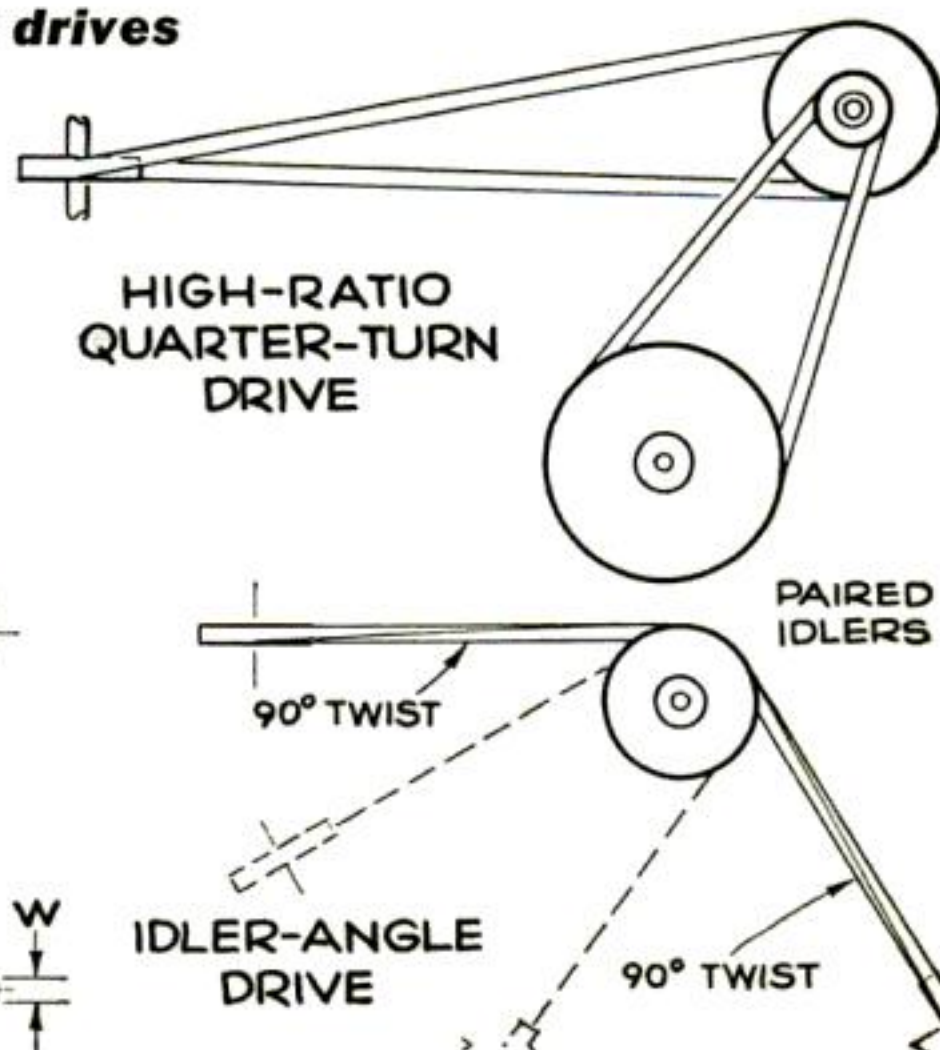
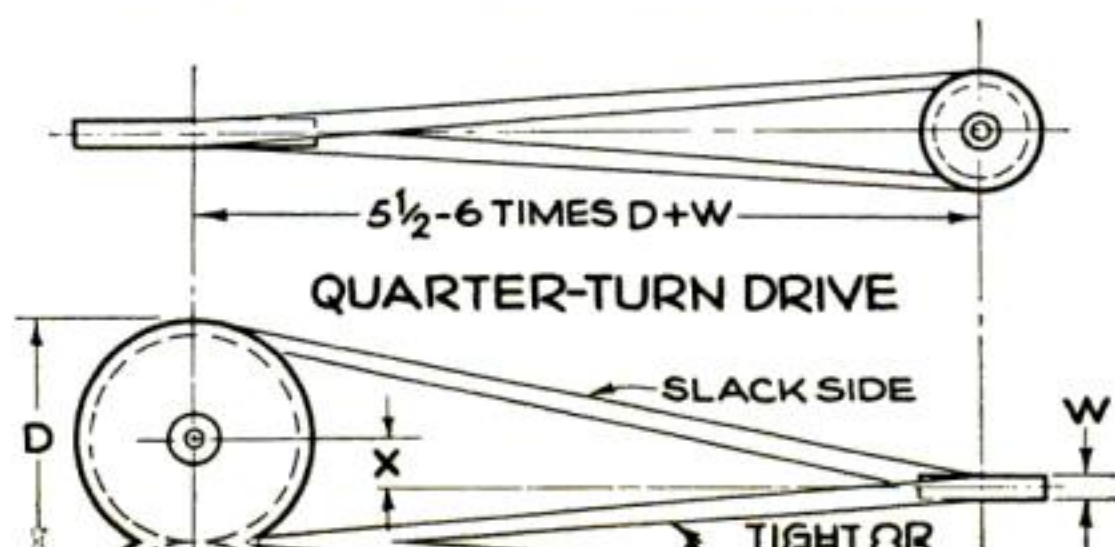
If the power rating is much less than required, the answer may be a special-duty belt, a heavier belt, or dual belts on double sheaves. If larger sheaves give excessive belt speeds or the wrong ratio, but smaller ones won't pull the rated load, a dual drive with smaller sheaves is the natural solution.

As the table shows, fractional-horsepower belts can handle much more than the term suggests. However, the figures are for easy drives, such as an electric

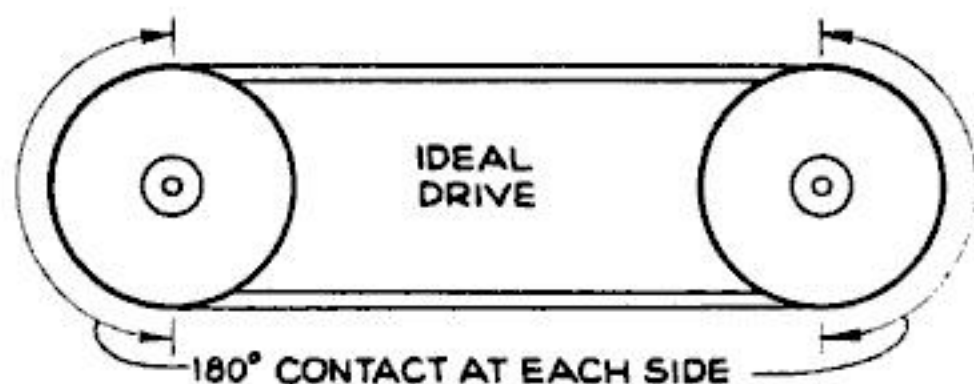
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How to rig quarter-turn and angled drives

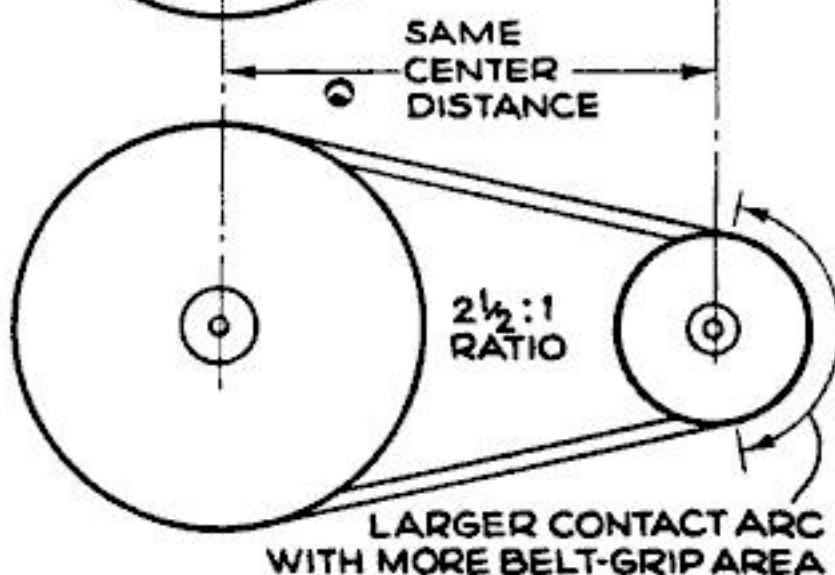
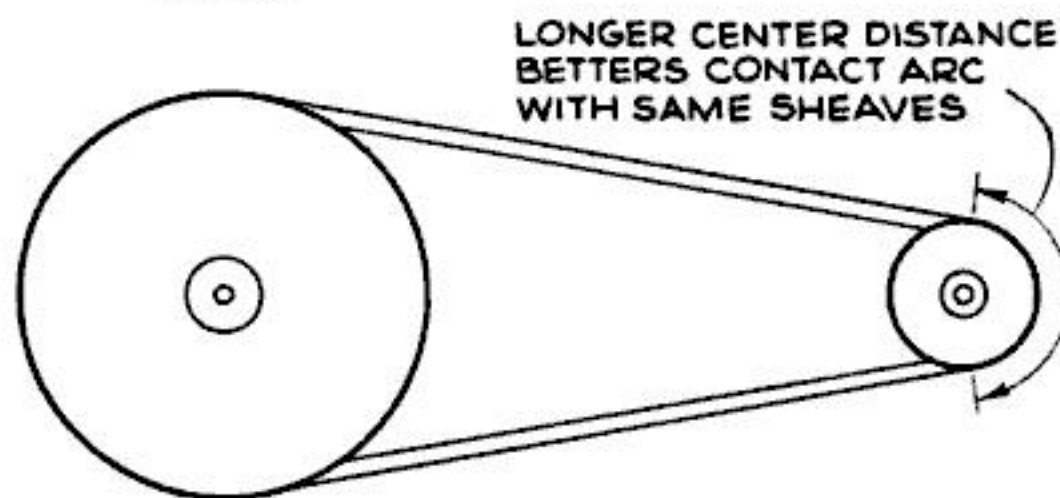
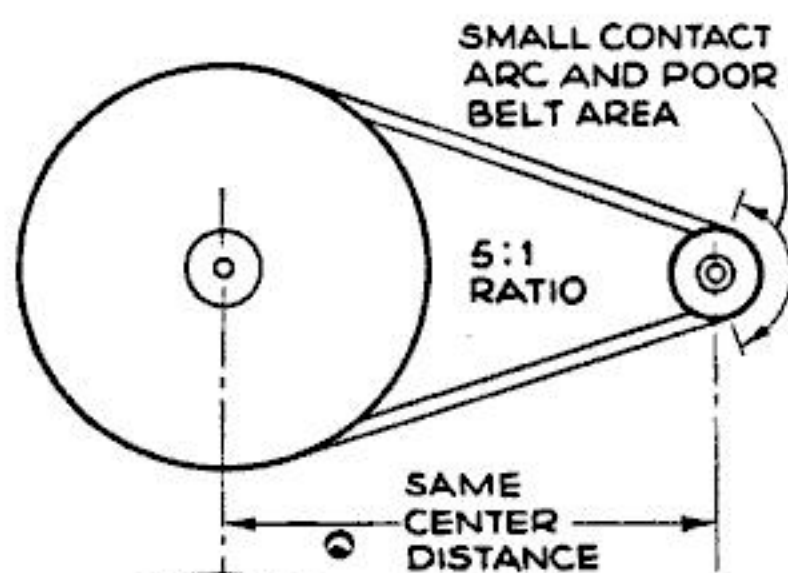
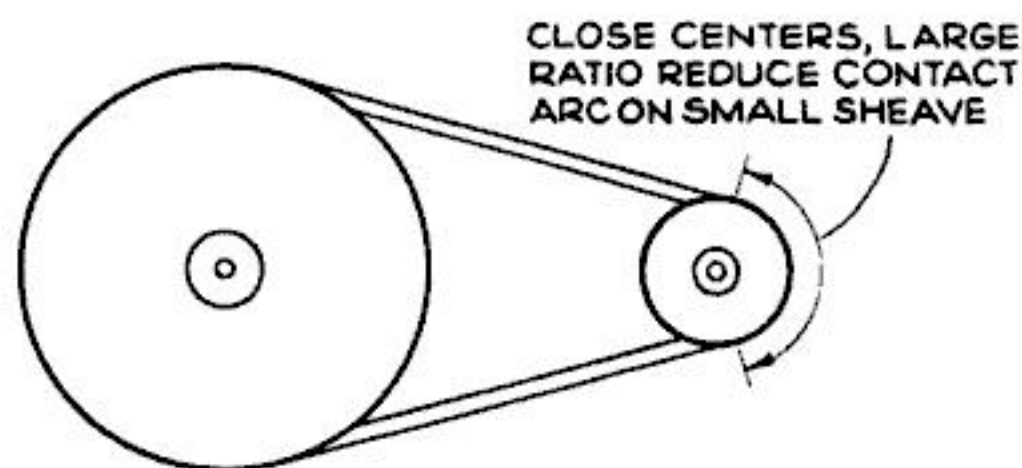
CRITICAL ALIGNMENT is mark of successful quarter-turn drives. Expect them to carry only 75 percent as much power as equivalent normal drives. Ignore dimension W for single-belt use, but figure offset X to keep the taut side of the belt as parallel to the small sheave as possible. If greater than $2\frac{1}{2}$:1 ratio is needed, use the two-step drive at right. With idler-angle drives (below, right) spacing must allow a 90-degree twist at each side of idlers, but the angles of the two shafts may vary widely around idler centers.



How pulley dimensions affect power ratings



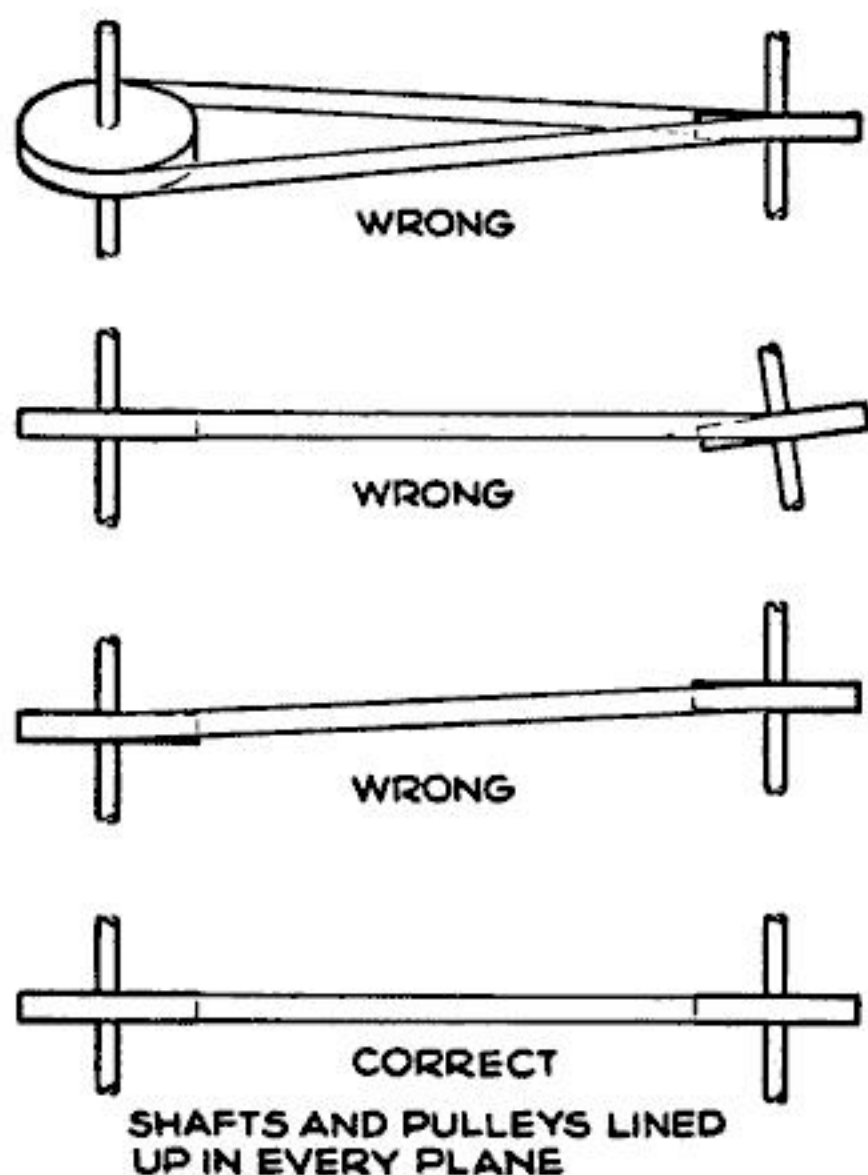
FOR FULL POWER RATING, keep the pulley ratio 3.1 or less (V-flat drives being the exception). Higher ratios (below) lessen the contact arc, introducing slippage and loss of power. The contact arc on the critical smaller pulley increases somewhat if the shafts are moved farther apart (below, left). Where a high ratio is required, it's best to use a two-step drive (that is, a countershaft) to avoid the use of excessive single-step ratios or an undersize pulley.



Horsepower Ratings for Light-Duty V Belts and Pulleys

Pulley Pitch Diameter		3L Belts				4L Belts				5L Belts			
		1.5"	2.0"	2.5"	2.9" & up	2.0"	2.5"	3.0"	3.8" & up	3.0"	3.4"	3.9"	4.7" & up
BELT SPEED (feet per minute)	500	.12	.18	.22	.25	.19	.31	.40	.49	.34	.48	.56	.72
	1,000	.19	.32	.38	.43	.30	.55	.71	.88	.60	.83	1.02	1.28
	1,500	.22	.42	.53	.59	.34	.72	.95	1.20	.75	1.06	1.37	1.76
	2,000	.23	.49	.64	.72	.34	.82	1.14	1.47	.78	1.20	1.63	2.13
	2,500	.21	.53	.73	.83	.28	.88	1.28	1.71	.72	1.26	1.80	2.42
	3,000	.15	.54	.78	.89	.15	.87	1.36	1.87	.58	1.23	1.87	2.63
	3,500	.03	.51	.79	.92	—	.81	1.37	1.97	.34	1.10	1.84	2.73
	4,000	—	.44	.76	.91	—	.67	1.31	2.00	.01	.84	1.69	2.69
	4,500	—	.32	.67	.84	—	.44	1.16	1.94	—	.42	2.15	2.53
	5,000	—	.10	.50	.72	—	.15	.92	1.78	—	—	.96	2.22

Faults that wear out belts



MISALIGNMENT OF SHAFTS, as in the top two drawings above, or offset pulleys (third drawing) lead to rapid wear of V belts, even if they run without jumping their pulley grooves.

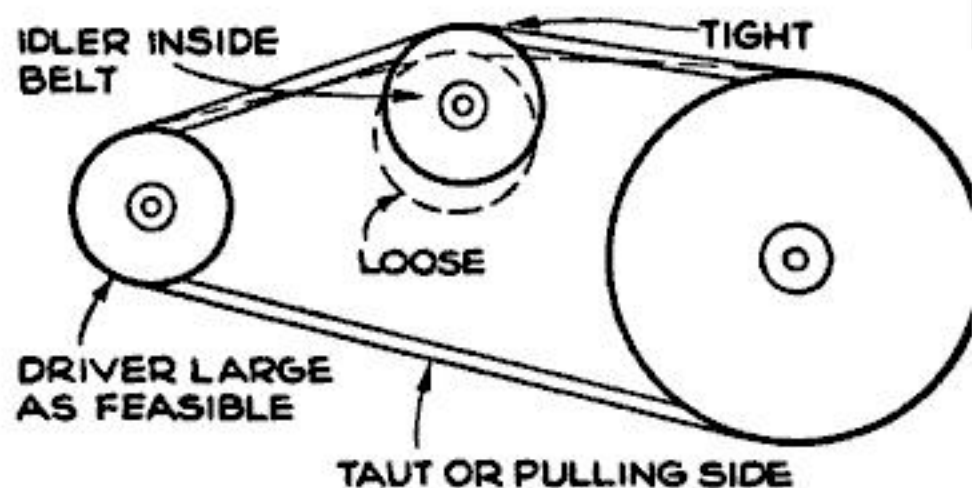
motor running a fan. Gas engines, with their pulsating power, are rougher on belts. Experts suggest "de-rating" their drives by an overload factor of 1.4. That means, with a 1½-hp. gas engine, your drive should have a capacity of 1.4 times 1½, or 2.1 hp.

The same holds for operating a "lumpy" machine such as a piston compressor, which also demands a 1.4 overload factor. Generators and centrifugal compressors call for an overload rating of only 1.2. So do hot or dusty operating conditions, high-starting-torque motors, and frequent starts and stops.

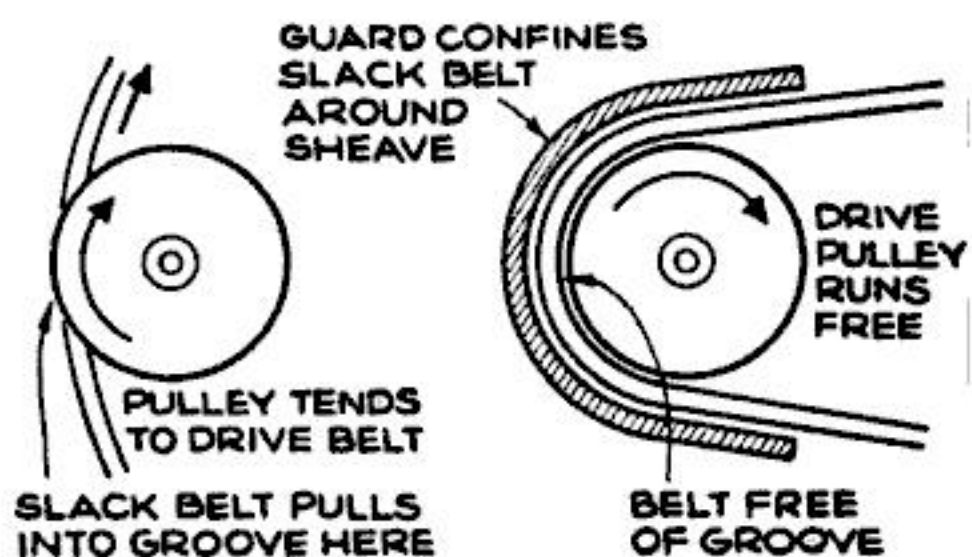
When both the power source and the driven unit call for de-rating, add the overload decimal of one to the other. Thus a gas engine (1.4) driving a piston compressor (1.4) calls for a drive 1.8 times as heavy as the nominal horsepower of the engine.

Avoid idlers. If possible, use a centrifugal clutch instead, or loosen and tighten the belt by pulling back either

Tips on using idlers



OUTSIDE IDLERS overstress belts; inside ones lessen the arc of contact and cause loss of power. If an idler is indispensable, use one of the same size as the drive pulley if possible, and mount it inside the slack side of the belt, nearer the larger pulley, as above. If a loose-belt clutch drags, it can sometimes be corrected with a guard on the drive sheave as shown below.



the driving or driven unit. Normal running tension in other cases should be provided by right belt length and take-up adjustment, rather than by idlers.

If you must use an idler, put it inside the belt, on its slack side, and near the larger pulley. So placed, its tendency to reduce the arc of belt contact will have less effect.

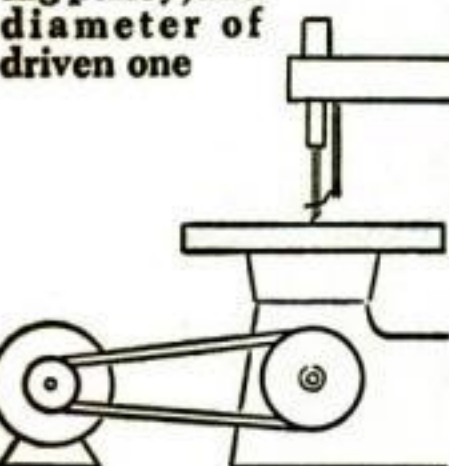
Idlers outside the belt force it into a reverse curve, shortening belt life. If you must mount one there, use a flat instead of a V pulley, at least 1½ times the minimum size shown for normal ones.

The right tension. Belt-tightening clutches sometimes drag even in the disengaged position, for the V belt's natural shape and resiliency tend to pull it into the far side of the driving sheave. This can be prevented with a close-fitting belt guard around the driving pulley. By constraining the tangent belt sections near the sheave, it prevents the far side from drawing in, as shown in a drawing.

V belts are meant to run tight. Slack-

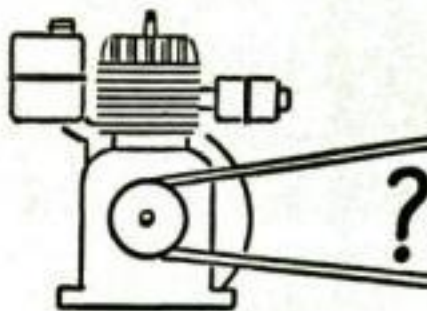
Easy Ways to Calculate Pulley Sizes and Shaft Speeds

IF YOU KNOW	AND WANT	DO THIS
Speed and diameter of driving pulley, and diameter of driven one	Speed of driven pulley	Multiply speed of driver by its diameter; divide by diameter of driven pulley



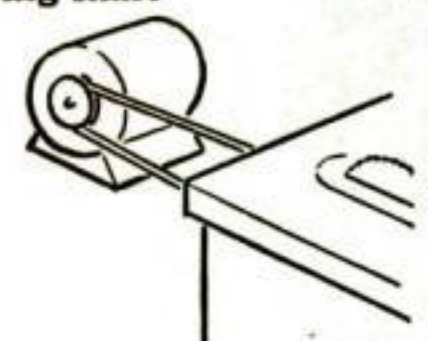
EXAMPLE: A 2" motor pulley turns at 1,750 r.p.m. to drive a 3½" pulley on a jigsaw. How many strokes a minute will result? Multiply 1,750 by 2; divide by 3½. Answer: 1,000.

IF YOU KNOW	AND WANT	DO THIS
Speed and diameter of driving pulley and required speed of driven one	Diameter of driven pulley	Multiply speed of driver by its diameter; divide by required driven speed



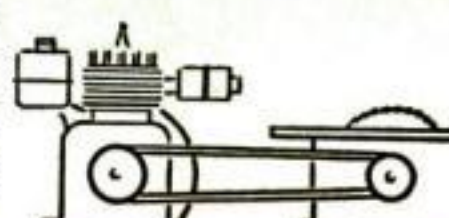
EXAMPLE: A countershaft is to turn at 1,650 r.p.m. when driven from a 3" pulley on a gas engine governor-controlled at 2,200 r.p.m. What size pulley is needed on the countershaft? Multiply 2,200 by 3; divide by 1,650. Answer: 4".

IF YOU KNOW	AND WANT	DO THIS
Required speed and diameter of driven pulley, and speed of driving shaft	Diameter of driving pulley	Multiply required speed of driven pulley by its diameter; divide by speed of driving shaft



EXAMPLE: A cut-off wheel to run at 4,000 r.p.m. has a 1¾" sheave on its arbor. What size driving pulley is needed on a 1,750-r.p.m. motor? Multiply 4,000 by 1¾; divide by 1,750. Ans.: 4".

IF YOU KNOW	AND WANT	DO THIS
Diameters of both pulleys and required speed of driven shaft	Speed of driving shaft	Multiply diameter of driven pulley by the required speed; divide by diameter of driving pulley



EXAMPLE: A gas engine with a 3" pulley is to drive a circular saw at 3,600 r.p.m. The saw shaft has a 2½" pulley. At what speed must the engine run? Multiply

ness causes slippage. This overheats the belt and deteriorates it.

There's an easy test. Pinched midway between pulleys with two fingers, a properly tensioned belt can be twisted no more than half a turn. A more exact way to check tension is to take a tachometer reading of both shafts. The driven one should read within a percent or two of the speed of the driving shaft. Any greater difference indicates excessive slippage.

Trouble-shooting V drives. Never apply belt dressing to cure slippage. Oil is fatal to traction, of course. Clean belt and sheaves with a volatile solvent. But if oil has penetrated the fabric, a new belt is needed.

If a belt slips even though well tensioned and clean, inspect the pulley flanges. If they are worn concave inside, no V belt can hold on them. Mount new pulleys. Caked dirt in the grooves, or pitted, rusty groove walls, can wear belts fast. Dress rusty groove faces with abrasive paper held on a flat block.

Rapid side wear and even breakage may result from misalignment of the two shafts. Check with a straightedge laid against one pulley. The pulleys must be both parallel and in alignment with each other.

Rapid wear may occur in the primary belt to a jackshaft driving more than one machine. This drive from the motor to the jackshaft should be rated for the full horsepower of the motor, plus any overload factor due to the nature of the driven machines. A multibelt drive may be necessary at this point even though single belts suffice for each machine take-off.

Be sure to take up on a new belt shortly after installation, when the initial stretch occurs—and before slippage and overheating damage it.

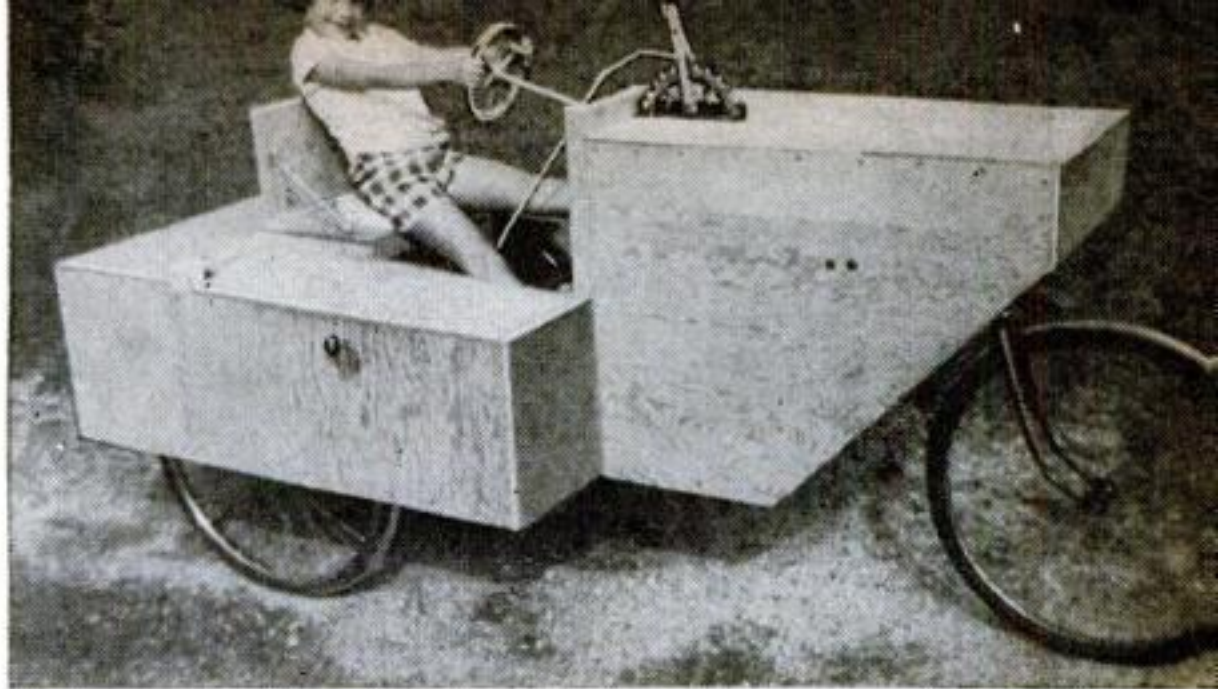
If a belt runs where it is subject to oil, dirt, and sawdust, consider protecting it with a suitable guard, or using a special belt designed for such operating conditions.

Premature belt failure may be due to a close-fitting guard that prevents ventilation and keeps the belt running hotter than it should.

Promptly replace a V belt that is oil-soaked, has its fabric peeling, or shows separation of its plies.

Motor-Driven Tricycle

roams
Vermont hills

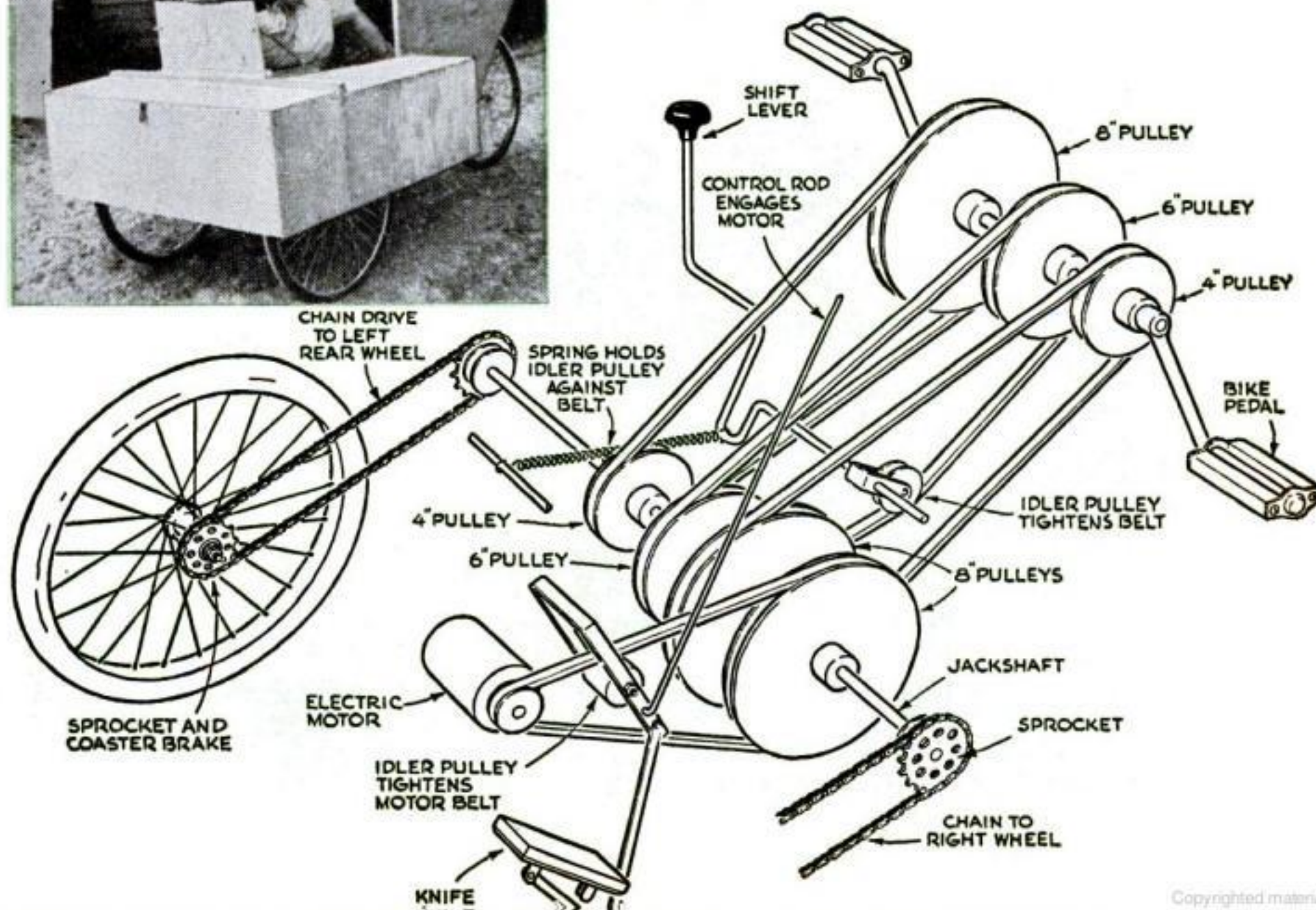
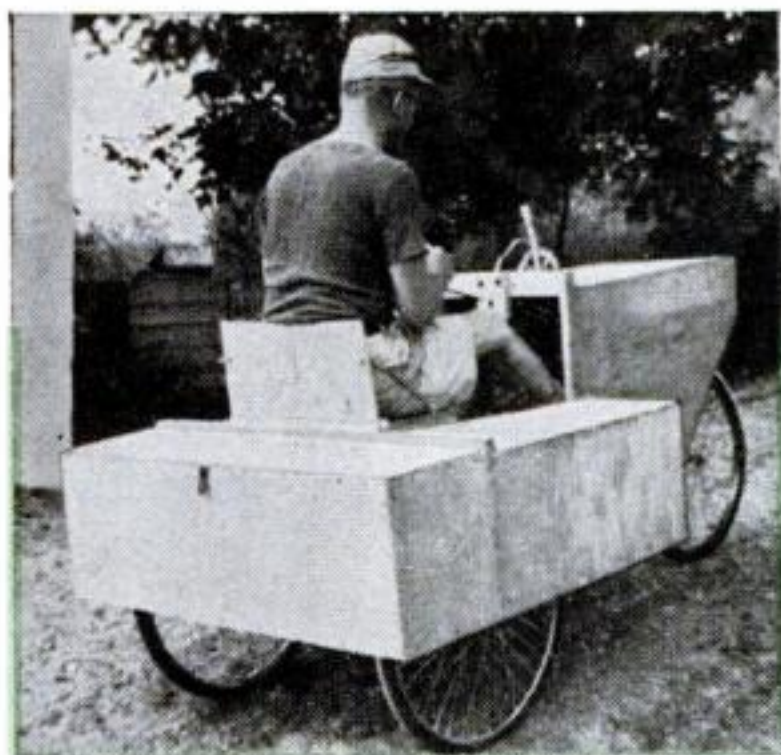


THERE isn't a hill that this three-wheeled "motortrike" can't climb lickety-split. Made from parts of old bicycles, it has a three-speed transmission that will get you up most grades on pedal power alone. When the going gets really rough, an electric motor cuts in to give you a power assist.

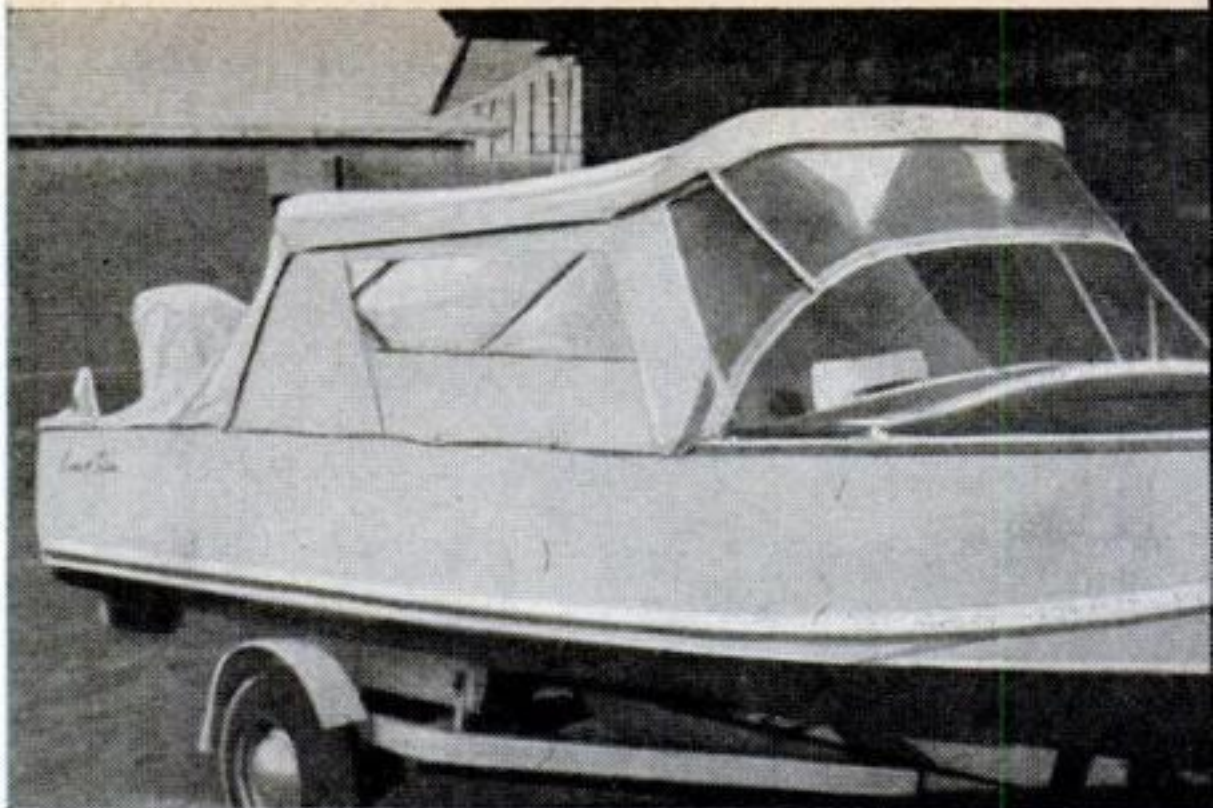
The strange-looking contraption was built to negotiate Vermont's rugged countryside by William R. Kimberly of Middlebury. He now spends much of his time explaining how it works to curious

passers-by. Ordinary bicycle pedals drive three sets of belts and pulleys, giving a choice of a 2:1 reduction for steep grades, a 1:1 normal drive, or a 2:1 overdrive for fast travel on level ground. A sliding idler pulley on a gearshift lever tightens the desired drive belt while the other two belts slip.

Twin chains drive both rear wheels through sprockets mounted on the pulley jackshaft. An ingenious differential action is provided by a standard over-running coaster brake on each wheel. When electric power is wanted, a second idler pulley tightens a belt from the motor to the jackshaft, at the same time closing a knife switch that turns on the current. The motor is from an old auto starter and runs on a periodically re-charged car battery.

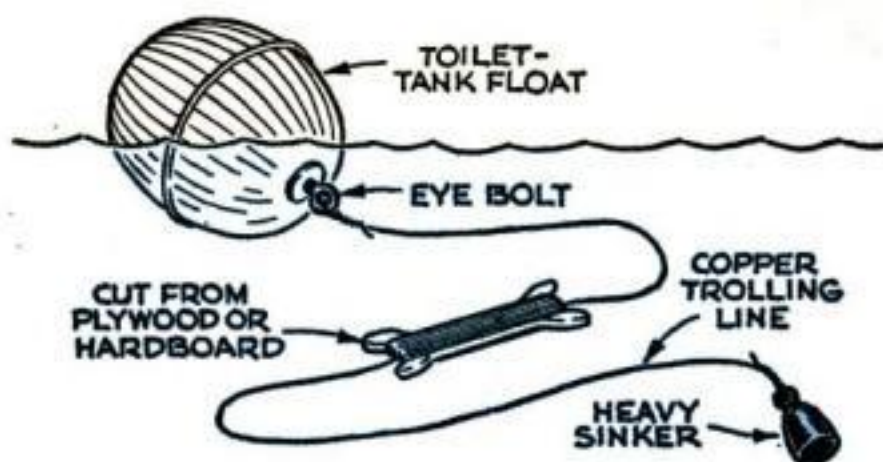


9 Hints for Better Boating

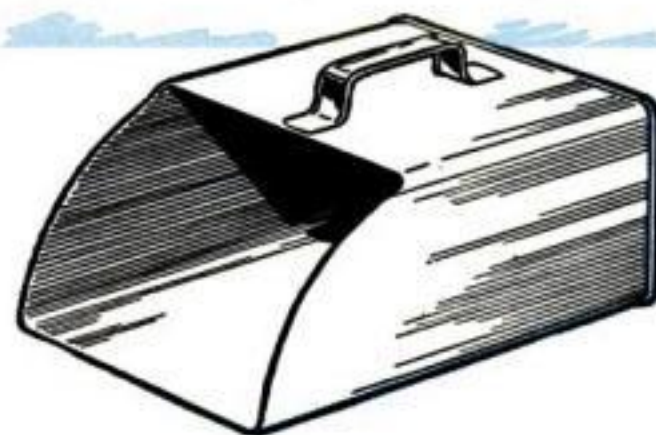


A windshield that's too low to afford adequate headroom for a canvas boat top can be extended as you see in the photo and sketches above. Use aluminum tub-

ing to make a new front support at the windshield 1" higher than the boat top's regular rear support. A sheet of thin clear plastic fills the space between the



Carry an emergency buoy to mark your position in case equipment is lost overboard or to mark good fishing grounds. A toilet-tank float makes an ideal buoy. Fit it with an eye bolt in place of the float arm and tie on a long line with a heavy fishing sinker at the end.—Victor H. Lamoy, Upper Jay, New York.

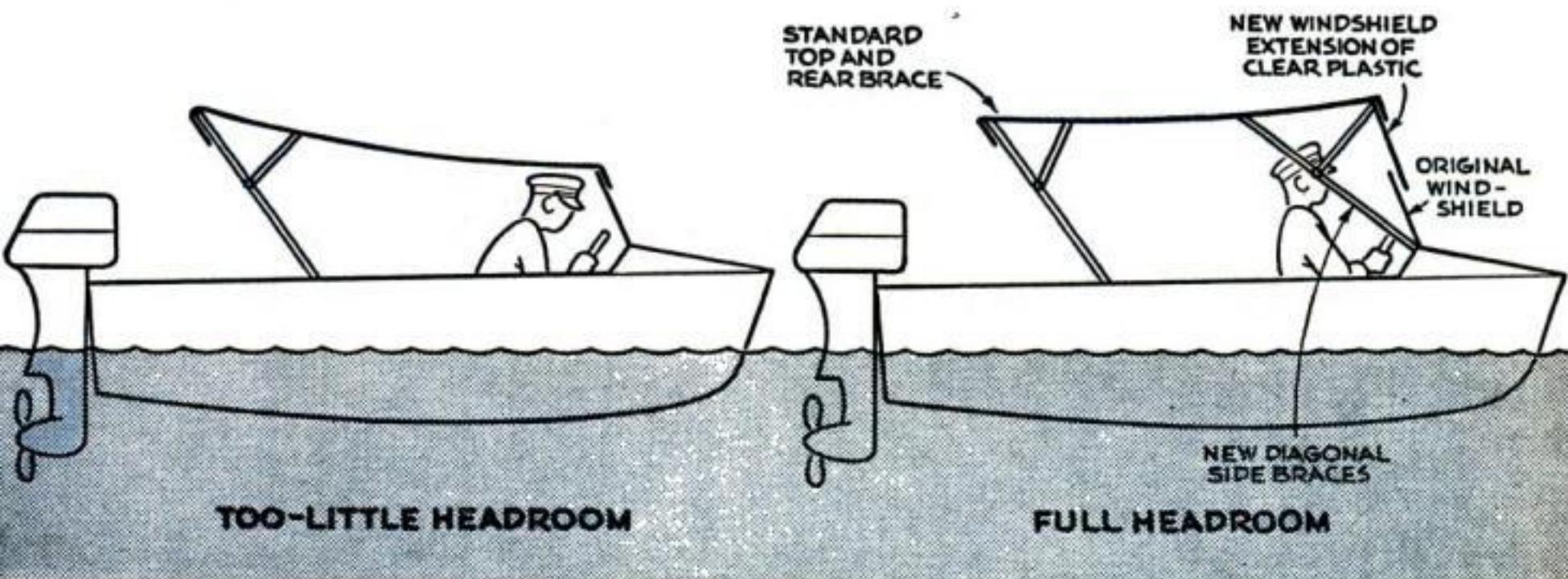


You can bail faster with a large, flat-sided scoop like this. Cut the end from an eight-quart oilcan, leaving a sloped-sided opening as shown. Unsolder the handle from the top and resolder it to the side. If you paint the bailer to match the color of the boat's interior, it will be less conspicuous and won't rust.



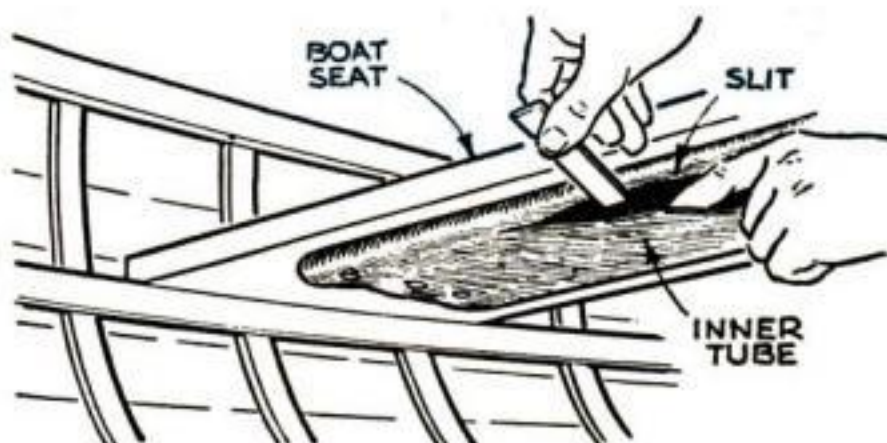
If you break a shear pin and have no spares, this trick will get you back to port. The pin usually breaks into two short pieces at the ends and one longer length in the middle (top left). Rearrange the pieces so the long one is to one side (lower left) and replace the prop. The long part of the pin will engage the hub for an emergency trip home.—D. N. Kofoed, Novato, Calif.

►►►Inexpensive grab rails can be added to a deck or cabin by using chrome towel bars. The bars are attractive and can be bought in any length up to several feet.—Donald E. Henry, Oquawka, Ill.



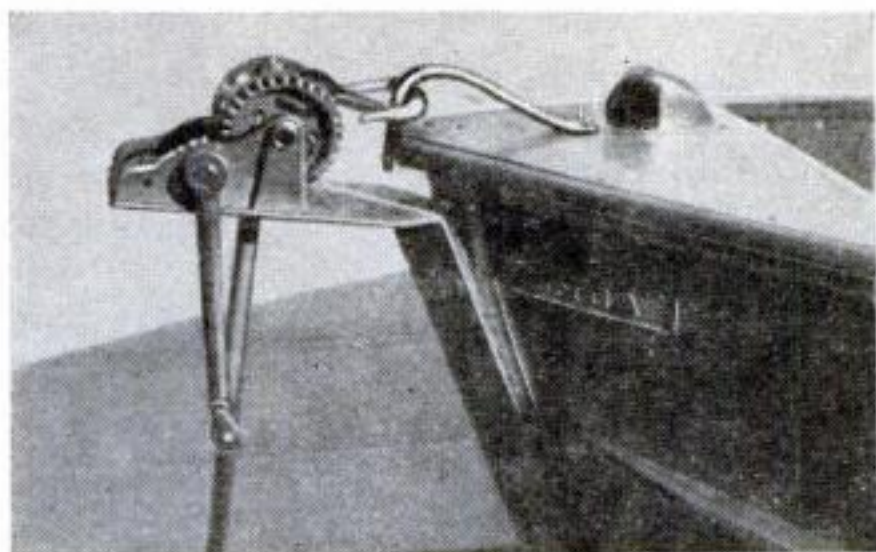
raised top and the original windshield. The plastic can be held in place by snap fasteners mounted on the windshield and along the upper and lower edges of the

plastic. You can make new side curtains out of plastic and canvas to the required height to fit between the top and the deck.—*Lee H. Schrimpf, Tulsa, Okla.*

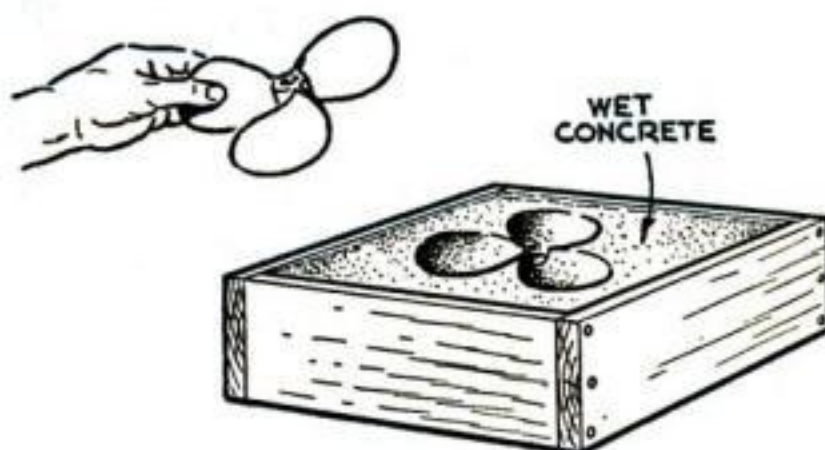


Stow small gear in a section of inner tube tacked by its ends beneath one of the boat seats. For the opening, cut a slit several inches long in one side.

A spare propeller can be safely stored in the unused bow space this way. A scrap dowel in a wood block screwed to the stem makes a handy peg to pin it on. The prop's cotter pin through the dowel locks the hub in place, and a rubber crutch tip snugs it against rattles.



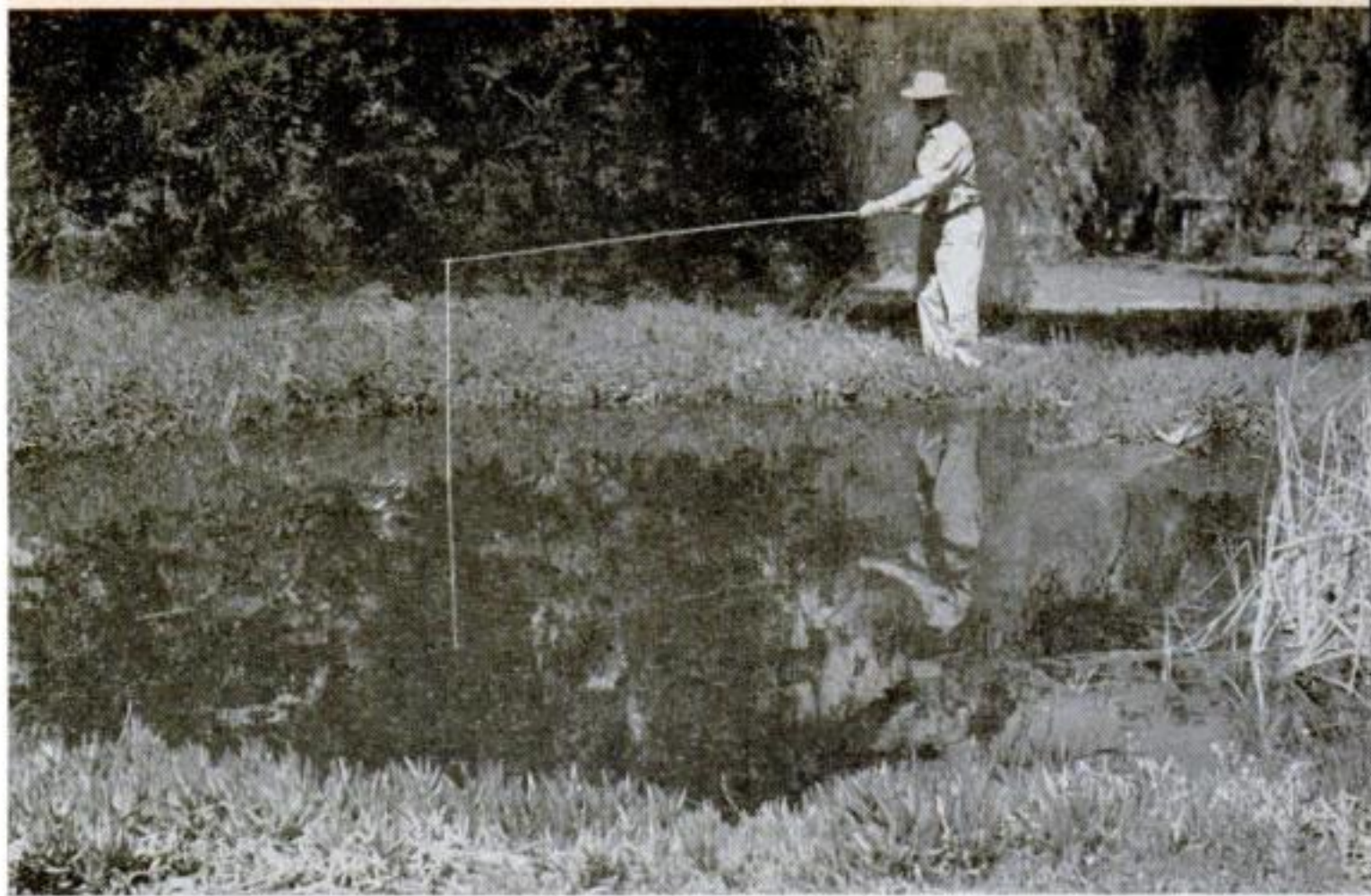
A boat-trailer winch requires less muscle when it's level with, or slightly higher than, the spot on the bow where you attach the line. A winch below this level causes the line to pull bow against trailer, increasing friction as the boat moves ahead. If the winch is higher, the line lifts the bow, lightening drag.



A bent propeller can be restored to original shape if you take its impression when new. Press the prop into a shallow box filled with stiff mortar and remove it immediately. Damaged blades can then be placed in the hardened mold and gently worked back to shape with a mallet.—*Ken Murray, Colon, Mich.*

I Fish in My Back Yard

By Hi Sibley



No long fishing trips for me—I just walk out the back door.

I STEP right out my back door into a fisherman's paradise. It's a small, home-built water hole so overflowing with mouth-watering bluegills that I can take out as many as 30 to 40 at a time.

A home fish pond is easy to build because it needn't be fancy—fish aren't fussy. Soon you have hours of relaxing fun as well as fresh, golden panfish such as you've never tasted before.

My pond is simply a shallow, irregular saucer scooped out by a tractor with a blade. No bulldozer is necessary. The sides are lined with a 1-2-3 mix of concrete. A bed of sand or gravel and steel

reinforcing mesh are advisable in frost areas. A drainpipe allows water to be drawn off and replaced to keep the pond fresh. A tub of water lilies provides cool shade for the fish on hot days.

To stock the pond, fingerlings can be obtained inexpensively at any state hatchery. I bought bluegills because they multiply like crazy. In a small pond, some extra food is required to supplement the natural supply—about a pound of chopped liver a week. The fish love it. U. S. Department of Agriculture Bulletin No. 1983 gives valuable information on raising fish in home ponds.



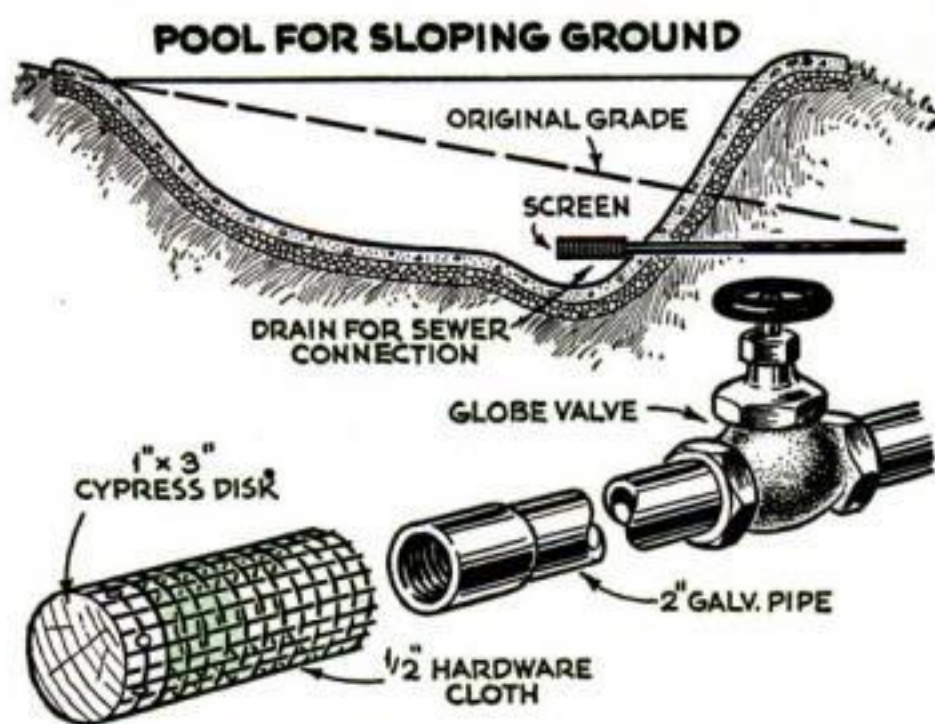
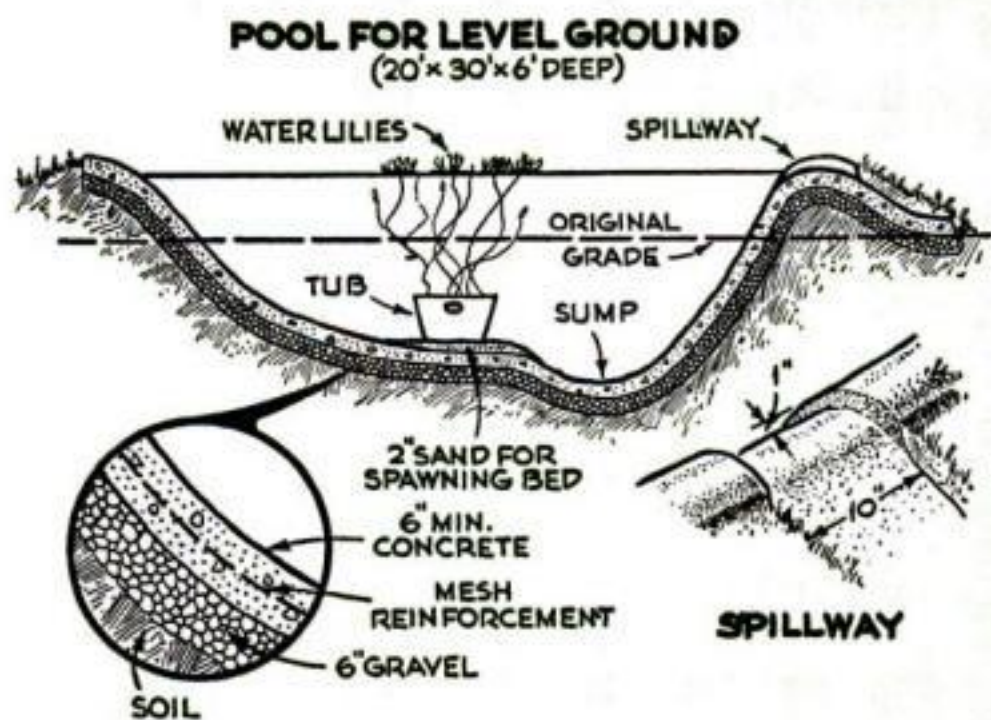
TWO-YEAR-OLD BLUEGILL is one of many good-size fish that can be raised in a home pond.



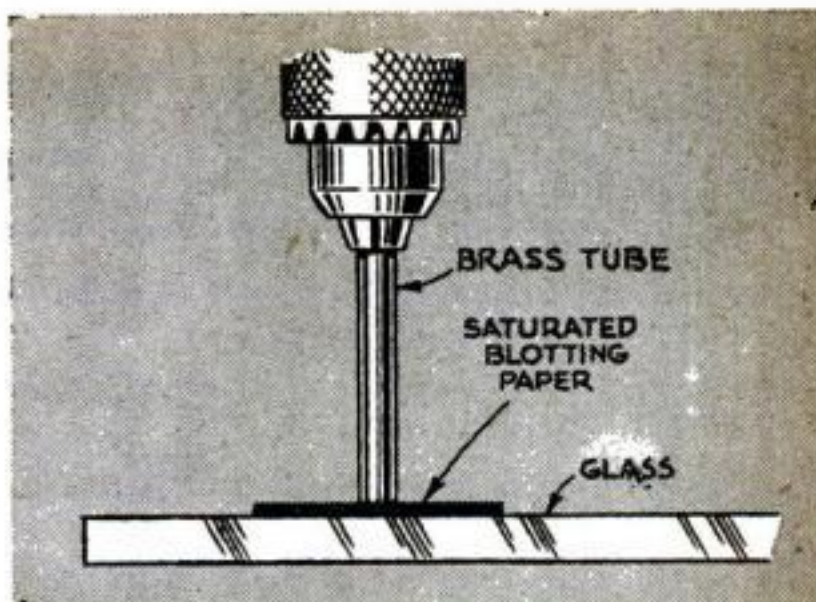
A TRUE FISH STORY: These 17 bluegills were all caught in one hour in the author's pond.



This is the life—how lazy can you get?

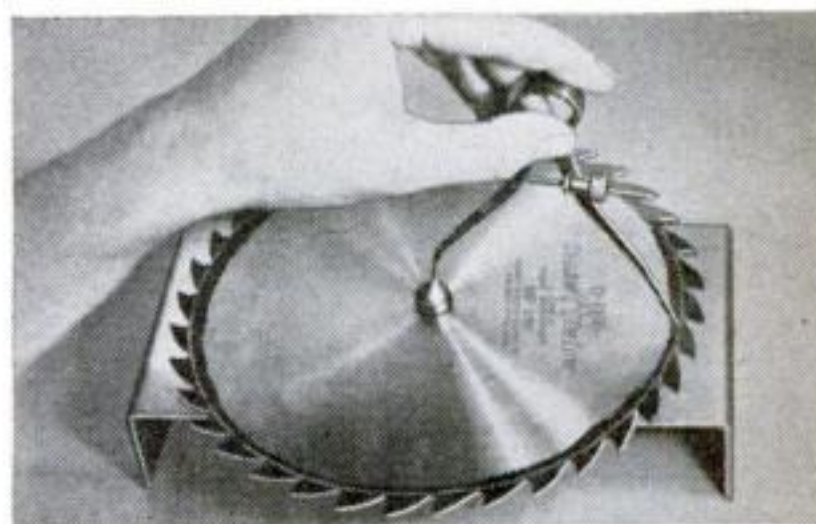


A SAUCER-SHAPED FISH POND can be put on either a level or sloping lot, as shown above.



Keeping a Glass Drill Moist

HERE'S a neat way to drill glass without the mess of building up a putty dam to hold the lubricant and abrasive. Lay a blotter over the spot to be drilled; keep it saturated with lubricant.—*W. C. Wilhite, Carlinville, Ill.*



Filing Saw Teeth Accurately

FILING the gullets of a circular-saw blade by eye is tough. Using dividers with a steel ball soldered to one leg to fit the blade hole, you can scribe a circle concentric with the teeth to give an accurate guide. For better visibility, use layout ink on the blade edge.—*Robert Micals, Freehold, N. J.*

Wall-Mounted String Cutter

A WINDOW-SHADE holder makes a handy string cutter to mount on the wall of your shop. Just file a sharp edge at the bottom of the slotted opening. Hooking the string into the slot severs it neatly.—*Wayne Floyd, Fayetteville, Tenn.*



My Amazing Lean-To Scaffold

By E. M. Harman

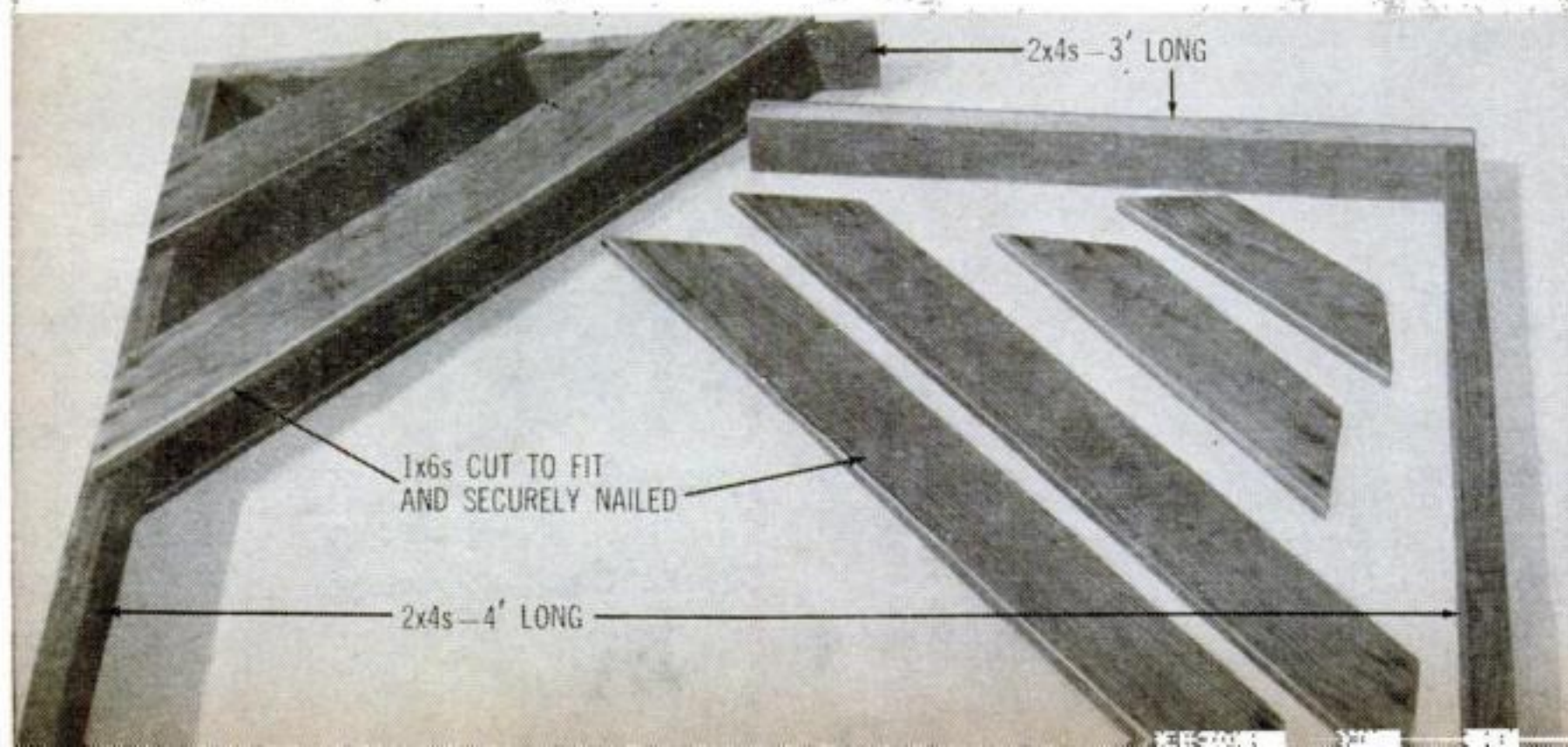
THIS lean-to scaffold is the result of a long process of elimination. When I started building our cabin in the mountains, I didn't know a floor joist from a window header. The framing was all precut, though, so I made out all right until time came to put on the knotty-pine siding. The cabin has two stories and is on a lot that slopes sharply front to back and side to side. The peak of one gable is 30 feet from the ground. I started building the scaffolding in a

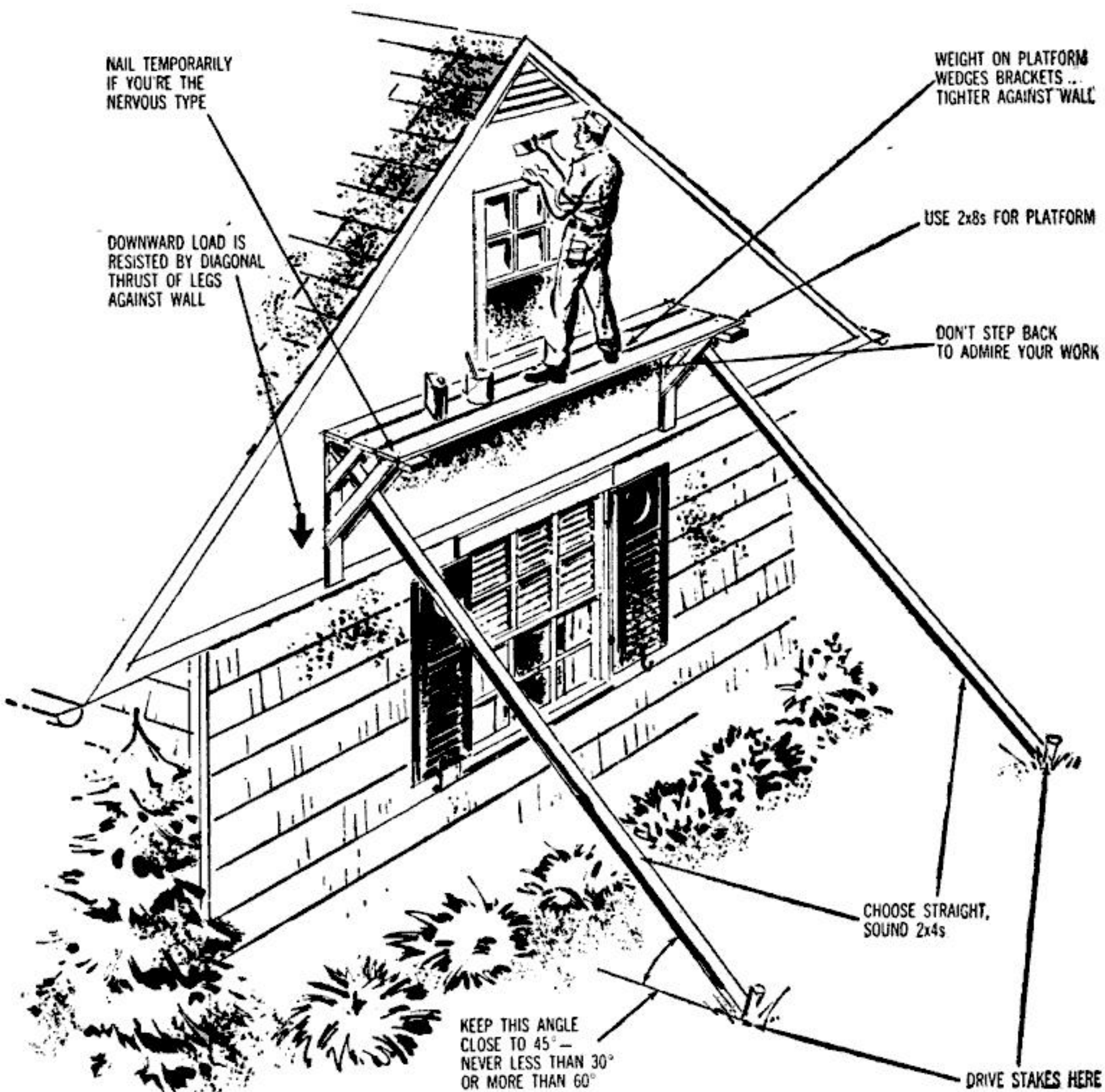
haphazard way and by the time I was through it was hard to tell where the cabin left off and the scaffolding began. Worse yet, the scaffolding couldn't be moved, raised, or lowered without completely dismantling it. Trying to simplify it to a point where I could adjust the height and move it as a unit, I began removing a brace here, a board there.

By accident, I discovered that the resulting scaffold didn't have to be nailed to the wall. After using it for several hours where I had first erected it, I started to move it. That's when I found I hadn't put in the temporary nails I had planned to drive through the up-rights into the wall. This was something—no nail holes to mar a finished wall.

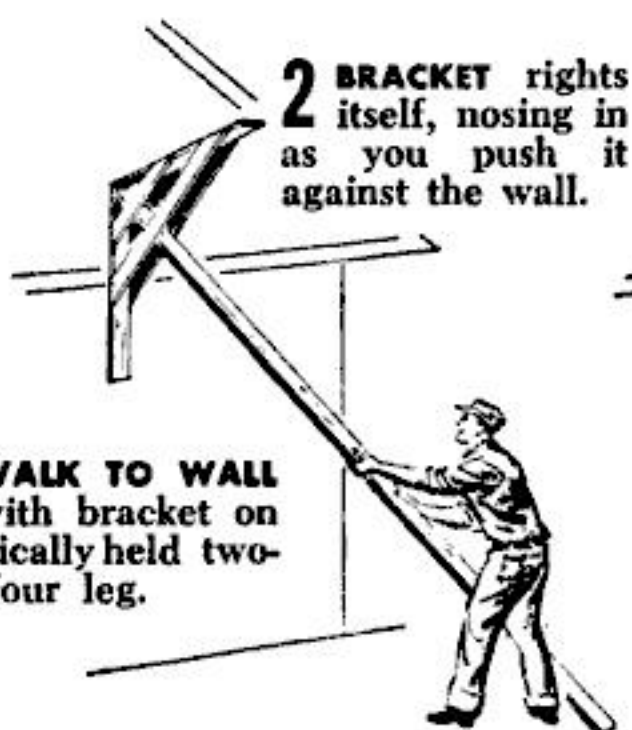
It's easy for one man to raise and lower this scaffold, as shown in the sketches. I've used it with the legs set at angles from 30 to 60 degrees without trouble, but I think it is wise to keep the angle as near 45 degrees as possible. I use two-by-eights for the platform. Usually I nail them to the brackets at each end—leaving the nailheads protruding for easy pulling. The nails don't seem to be essential, but psychologically I find they're worth the extra effort.

IT WORKED SO WELL on my cabin that I made a scaffold to use around home, too. With it, I made short work of painting garage overhang. Photo below shows how brackets are made.

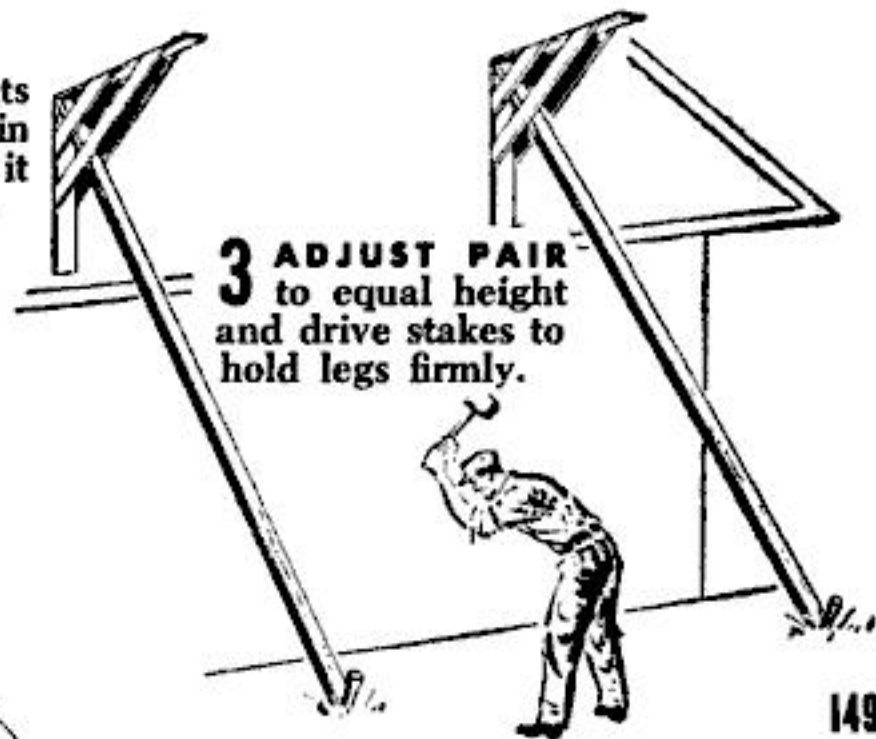




1 WALK TO WALL
with bracket on
vertically held two-
by-four leg.



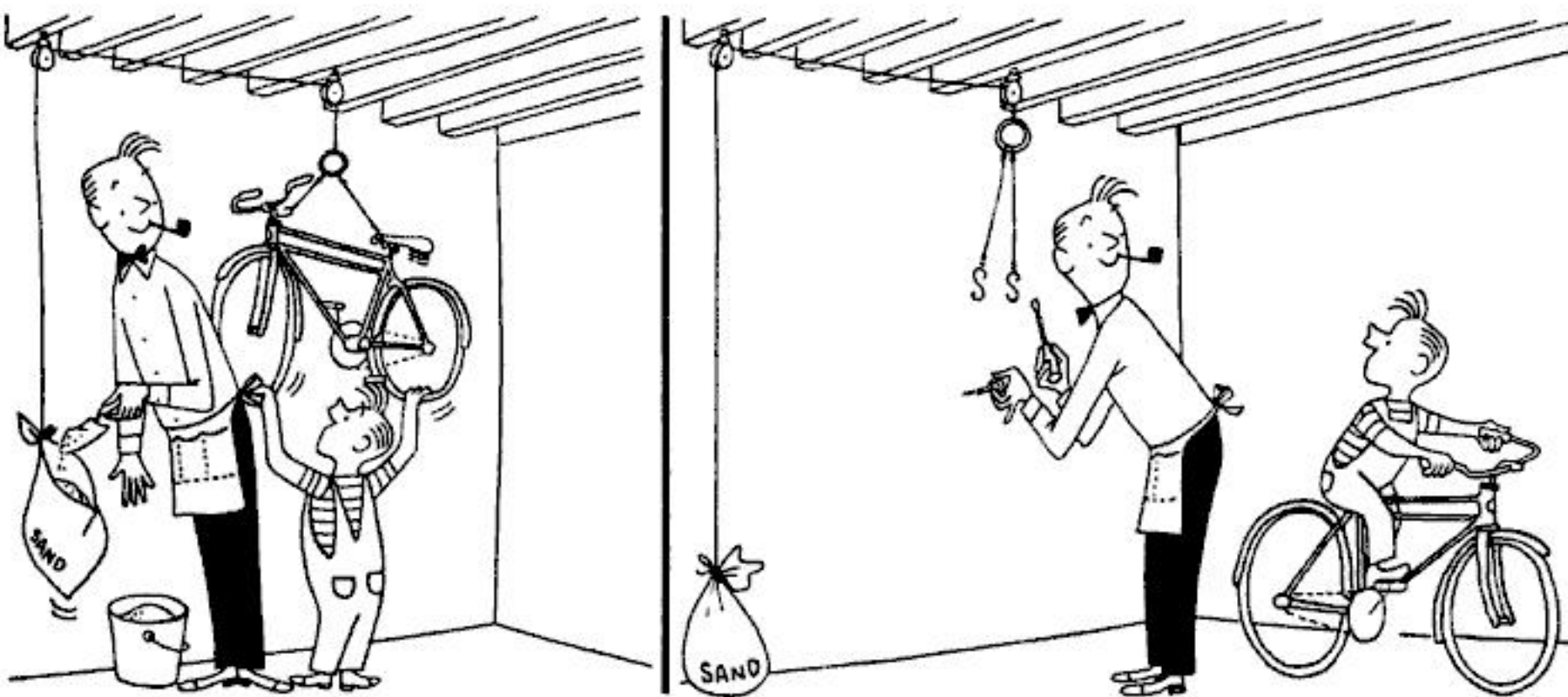
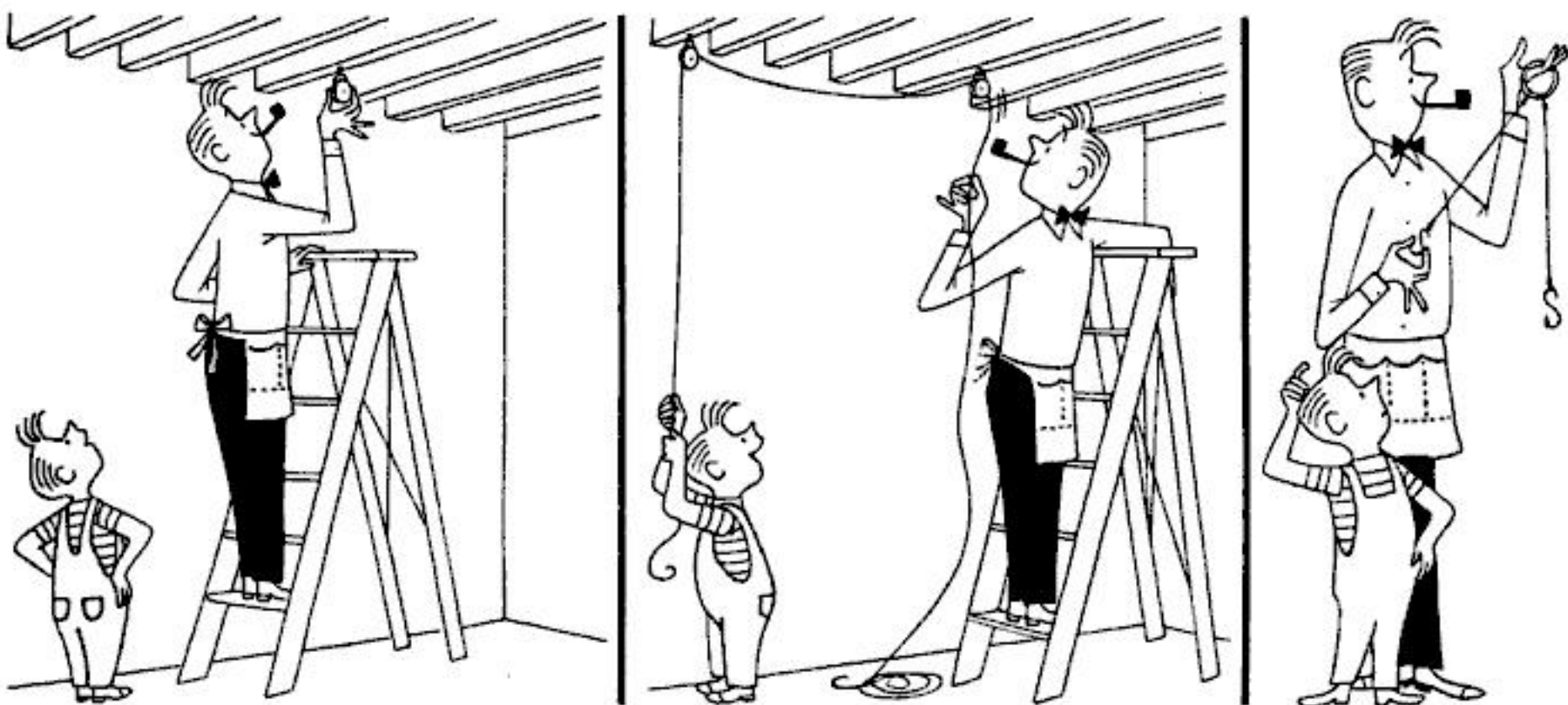
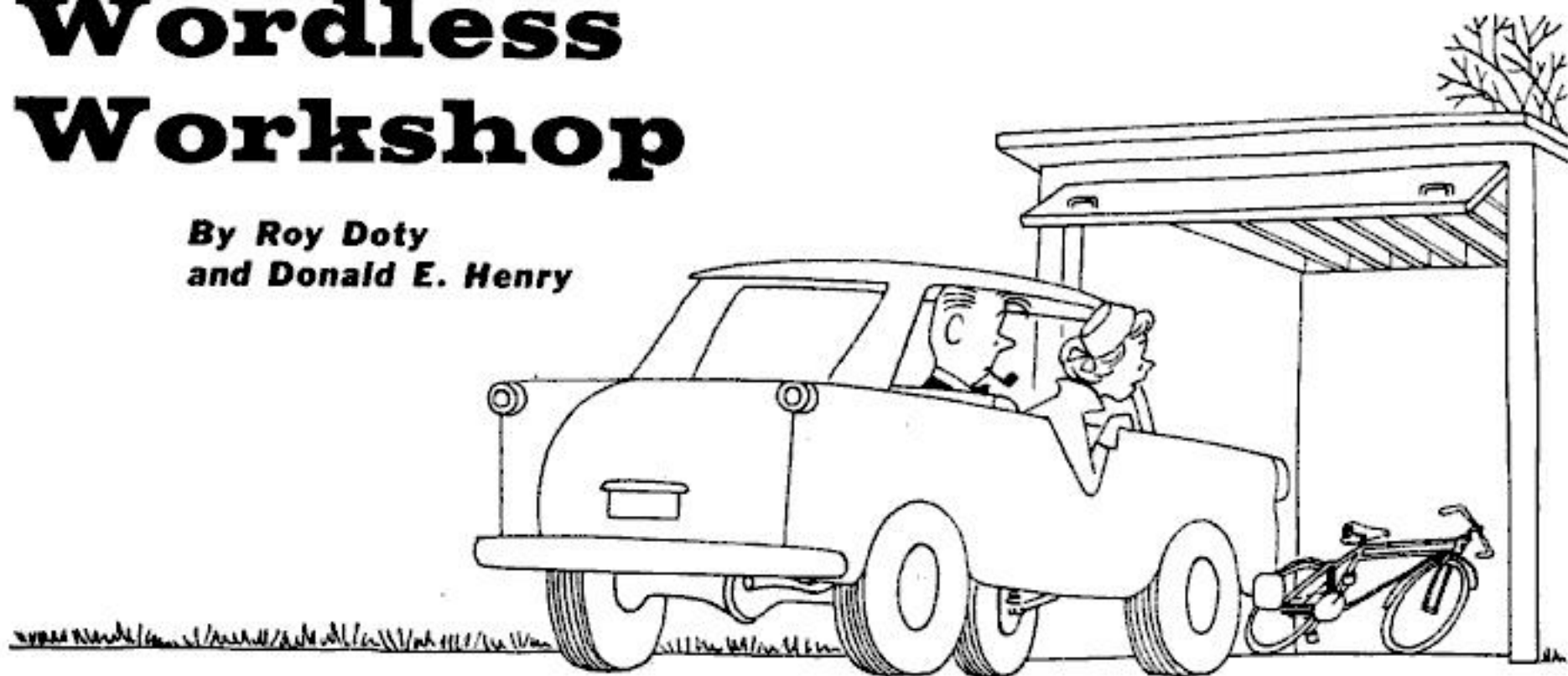
2 BRACKET rights
itself, nosing in
as you push it
against the wall.

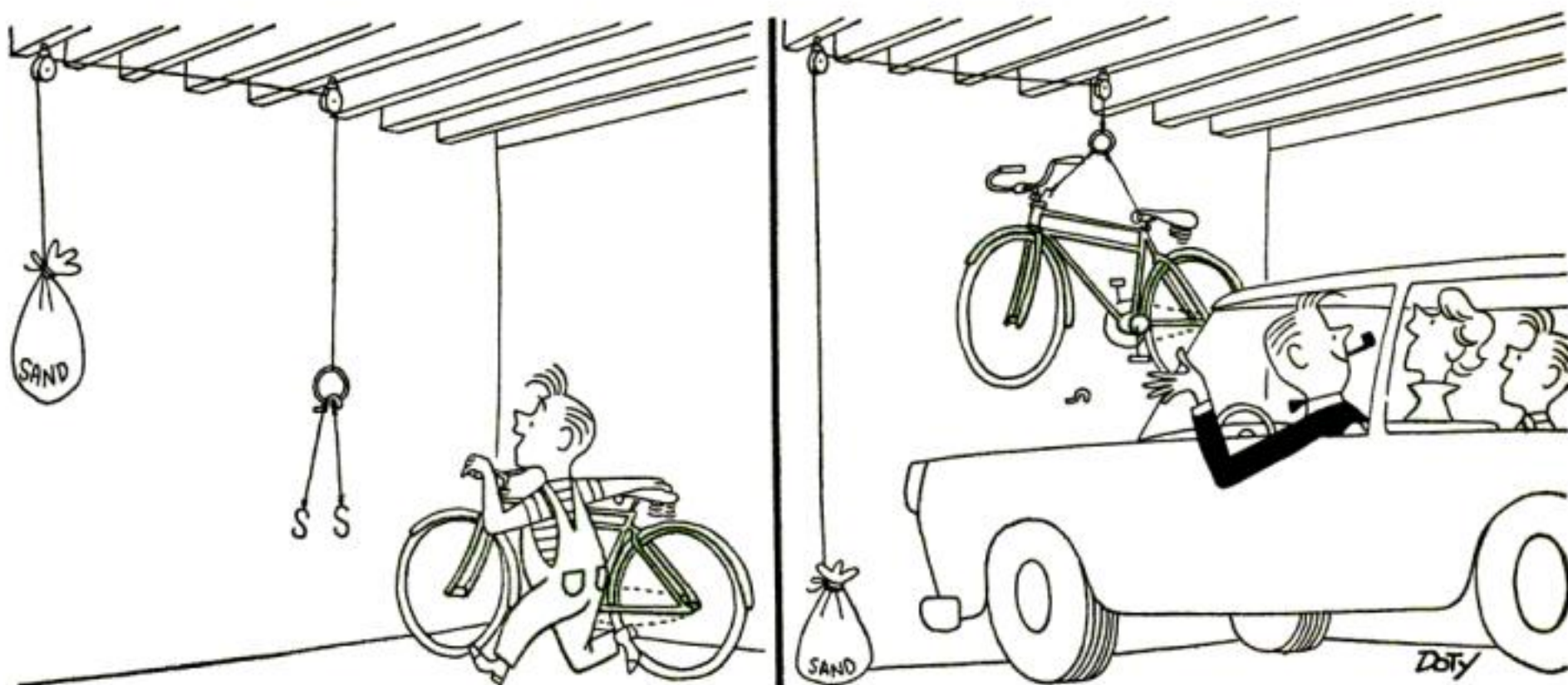
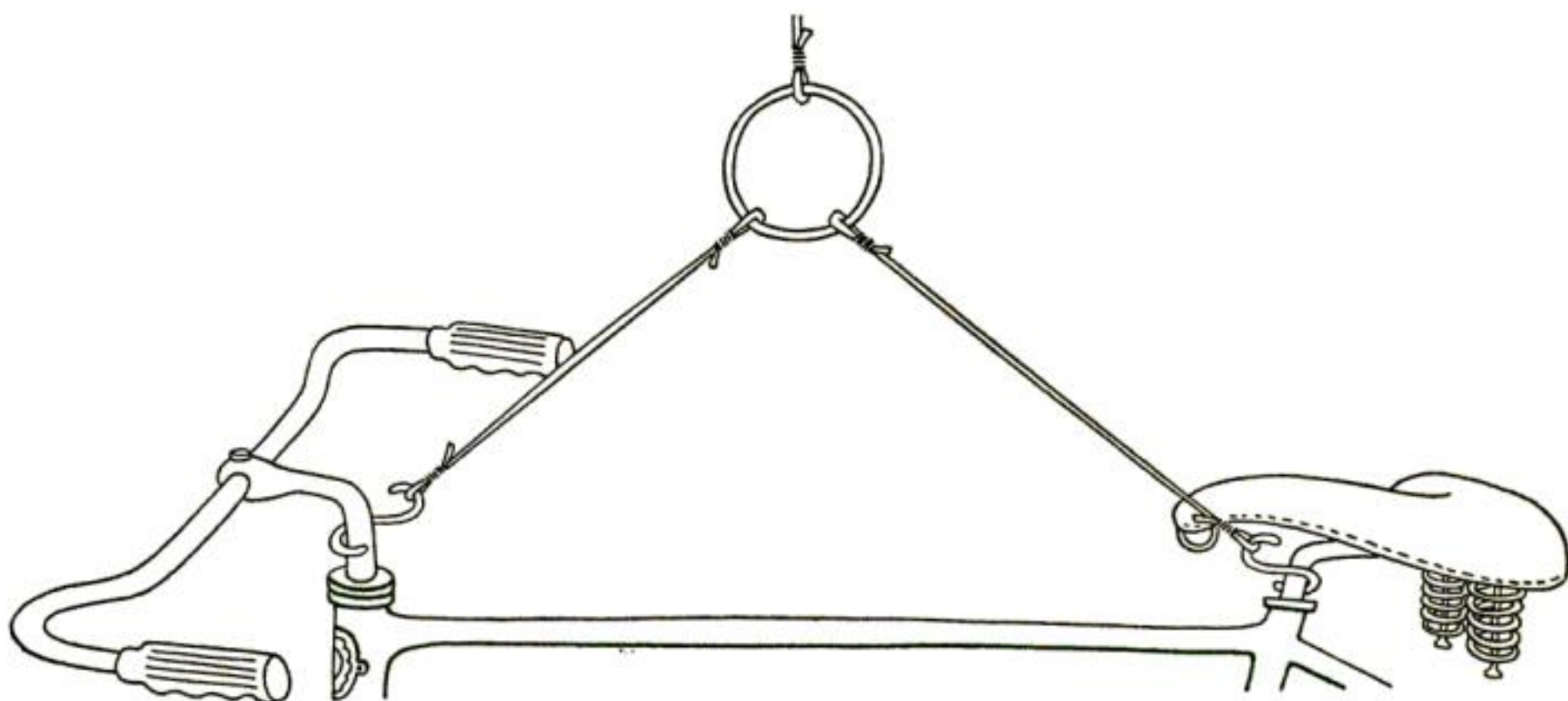


3 ADJUST PAIR
to equal height
and drive stakes to
hold legs firmly.

Wordless Workshop

By Roy Doty
and Donald E. Henry





SHOP-USE REPORT on the Maximat 10" Precision Lathe

By Herbert R. Pfister

MACHINING operations you've only dreamed of tackling on standard lathes are routine with the new Maximat. It's a multipurpose tool designed with a single idea—to cram a maximum of machining ability into a single machine.

The husky precision lathe can be converted in minutes to a vertical milling machine, jig borer, or drill press to handle almost any job a machinist can demand of it. Made in Austria, it is the big brother to the Unimat, a versatile metal-working tool already familiar to model-makers and hobbyists in this country.

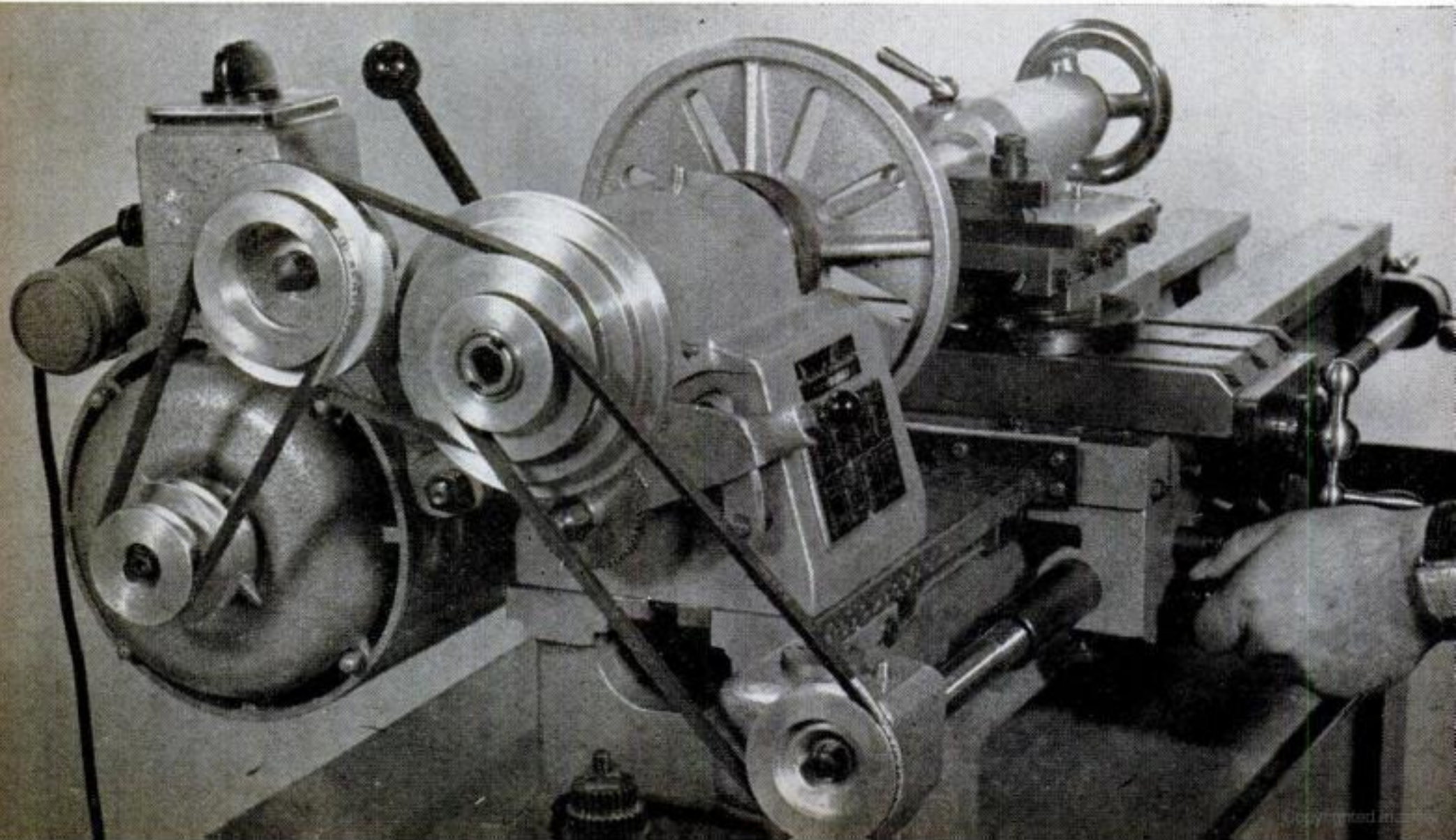
The workmanship in the tool is excellent, and using it is a delight. Massive parts respond easily to the controls. The tool bit bites with assurance into work chucked in the solidly built headstock—you wonder if you *could* make this ma-

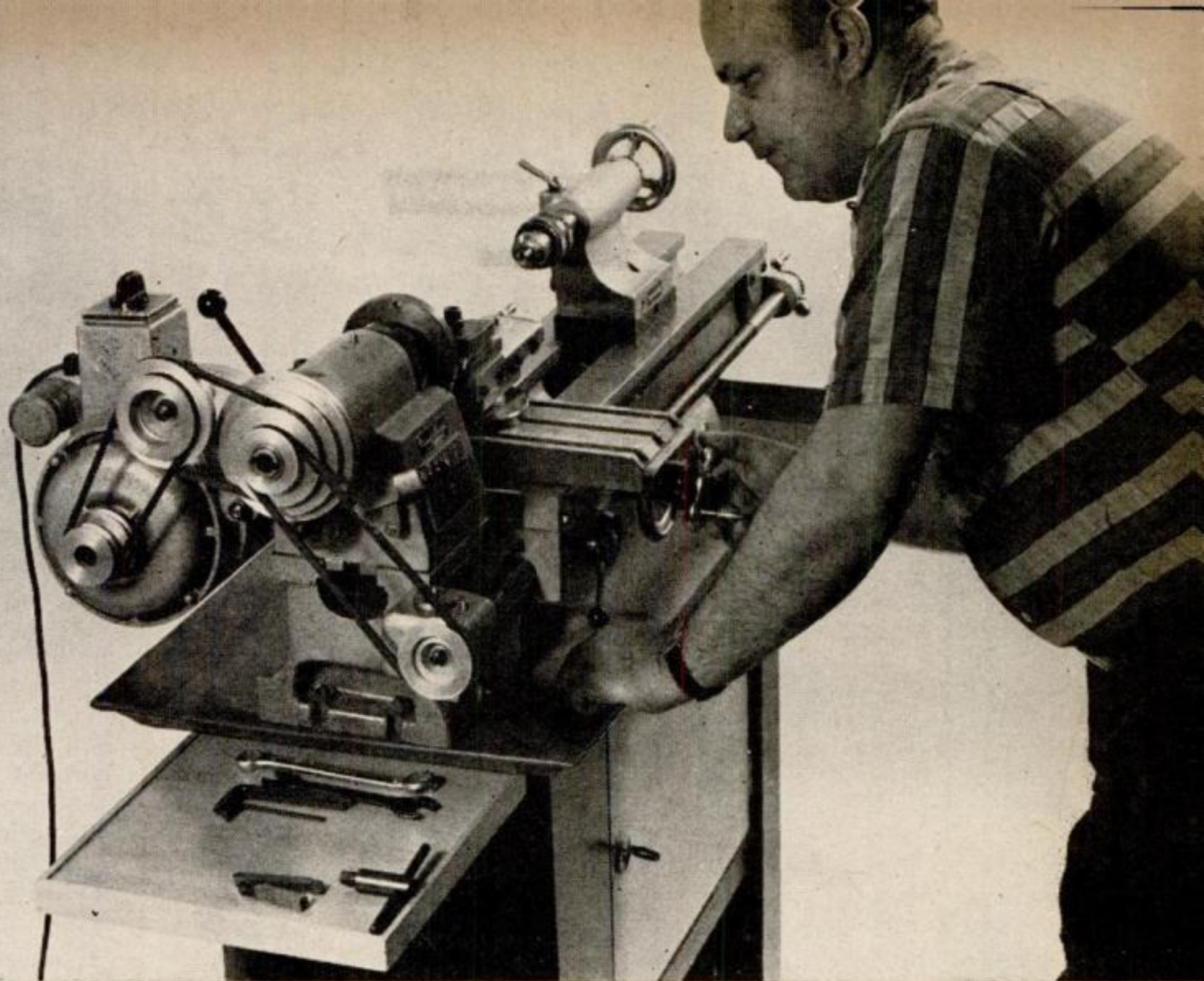
chine chatter or squeal. But there are a few disadvantages.

The tool lacks features expected as standard by American machinists. For example, there is no provision for indexing work held in the headstock. The tool post holds the cutter bit level—you can't adjust the angle at which it meets the work. One nuisance: The motor switch must be turned to a start position to energize the motor's starting winding before advancing it to forward or reverse.

The tool is marketed by American Edelstaal, Inc., 350 Broadway, New York City. The basic machine is priced at \$795. Equipping it for multipurpose duty as illustrated can add several hundred dollars to the base price.

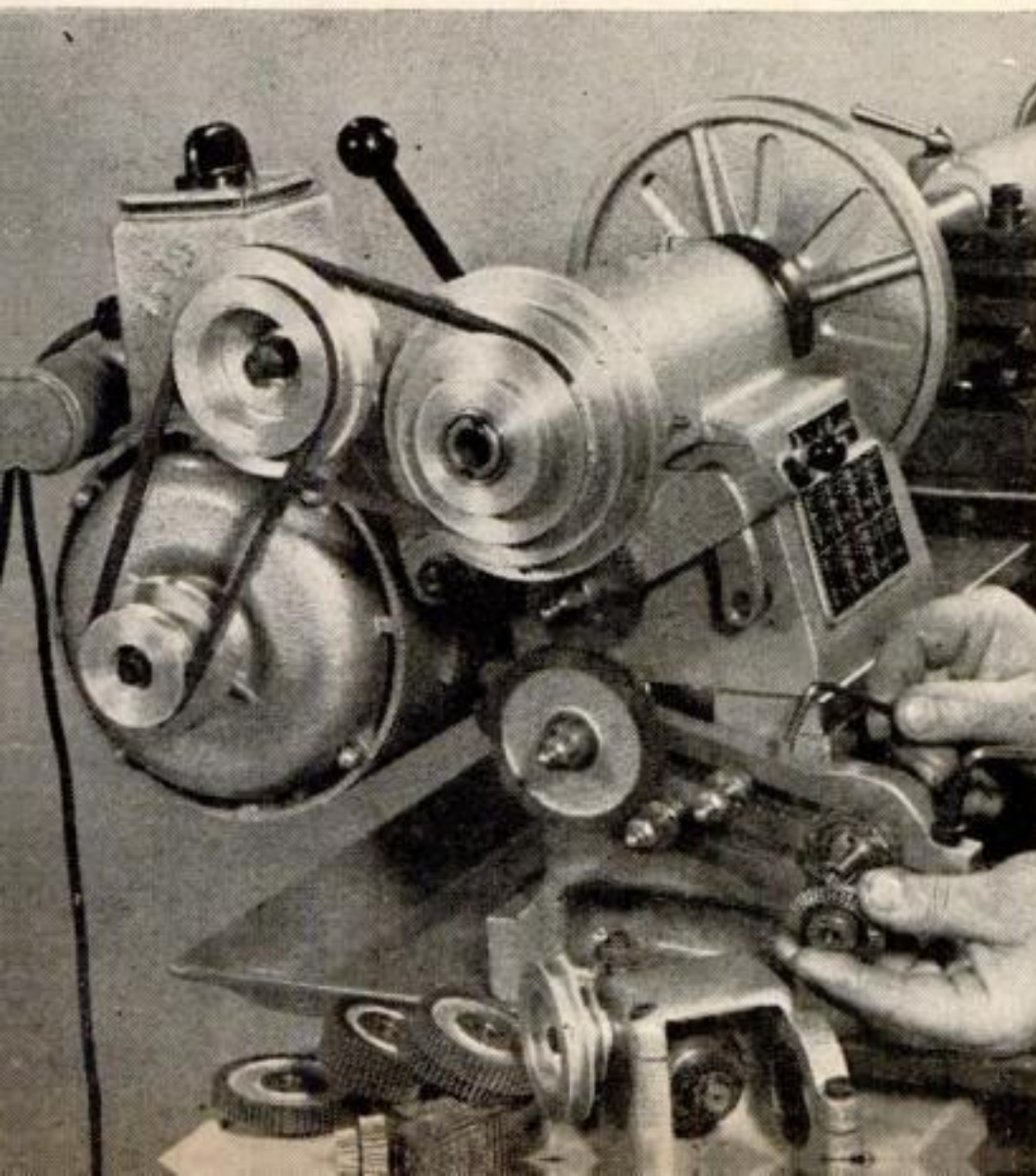
QUIET LEAD-SCREW DRIVE through V belts permits automatic carriage feed without setting up change gears. A separate motor can be used to drive the lead screw for independent control of carriage feed and spindle speed.

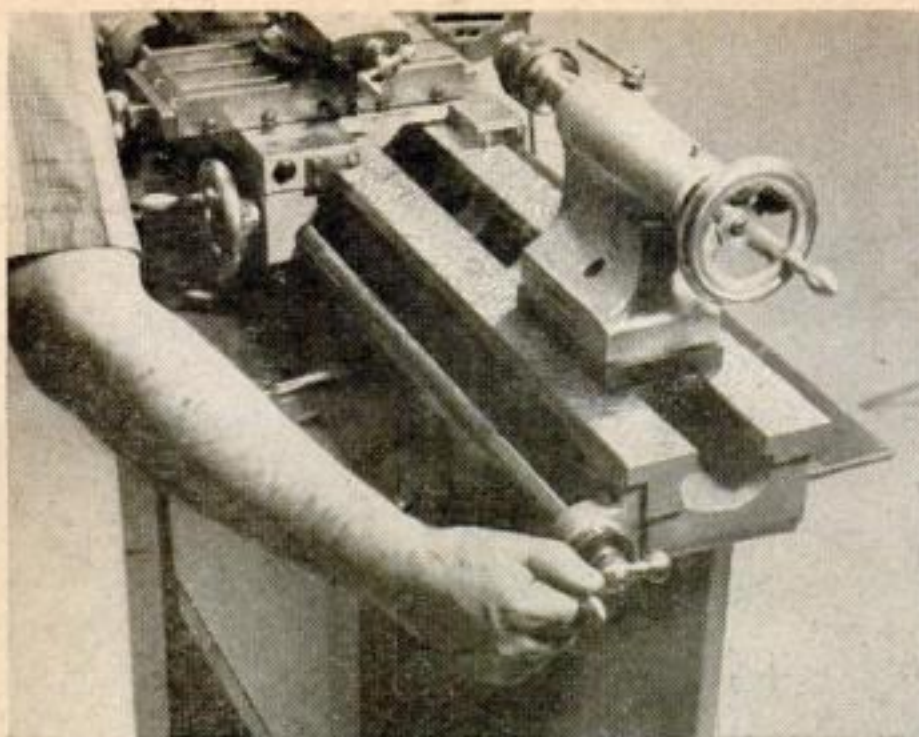




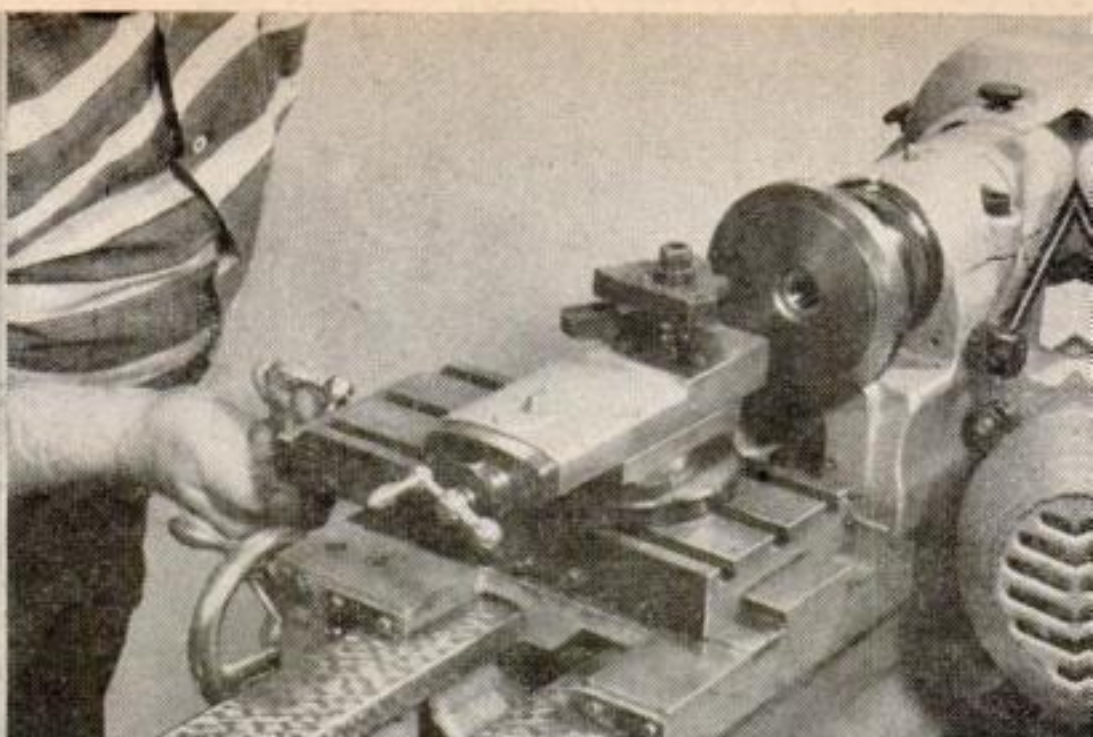
FOR THREAD CUTTING, a change-gear carrier is installed in place of the pulley box on the lead screw. Gears are selected and installed on the carrier in the usual way to lead the carriage for the thread pitch desired.

NO OIL THROWOUT FROM THIS MACHINE: All bearings, including those on the change-gear carrier, are equipped with small grease fittings. A special push-type grease gun is part of the standard equipment of the lathe.

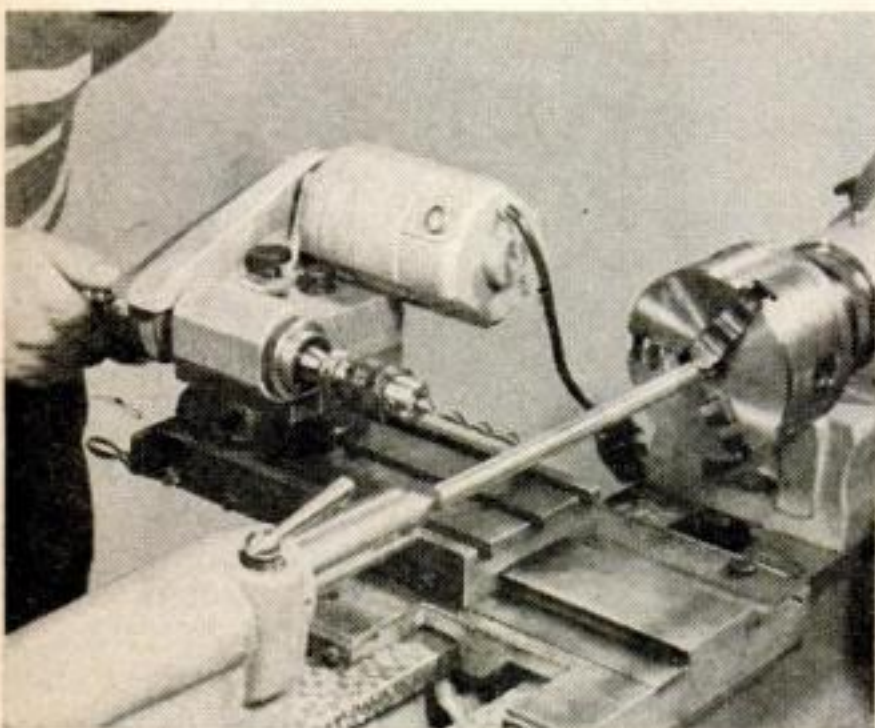




HANDCRANK on the tail end of the lead screw permits fine manual carriage feed for delicate turning, or for jobs such as grinding, when the work is held stationary between centers. The lead screw is mounted on ball bearings.



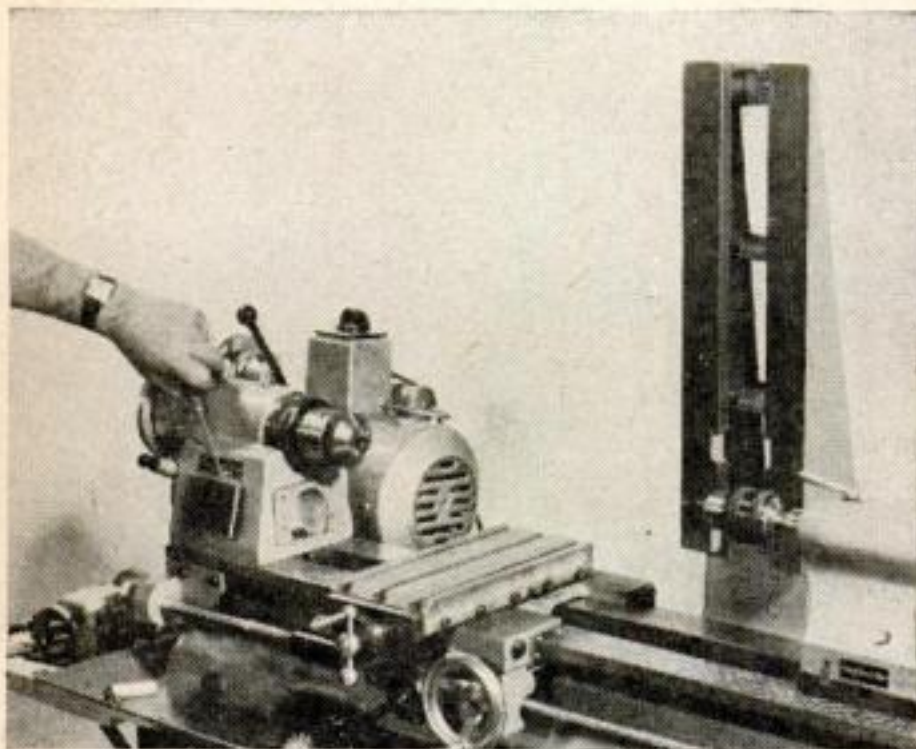
EXTREME ACCURACY of the chuck and collet nose results from custom-fitting their mounting plates to the headstock spindle. The plates are screwed on the spindle, and then faced and shouldered to insure perfect alignment.



TOOL-POST GRINDING ATTACHMENT comes with chuck for cross-drilling work held between centers. With the proper wheels and shank-mounted stones, external and internal precision grinding can be done, using power feed.



CONVERSION TO VERTICAL MILLING MACHINE takes only minutes. Vertical bed bolts to rear of main bed, and headstock is removed from lathe and mounted vertically. Prying off nameplate (left) exposes bolts that lock headstock in place. Setup illustrated above shows the milling operation. Vise is bolted to T slots in the wide cross-slide table. Headstock spindle can be fed downward by a hand lever for drilling, and locked in position for milling.





Short Cuts and Tips

FROM PS READERS

Starting Plants in Paper Cups

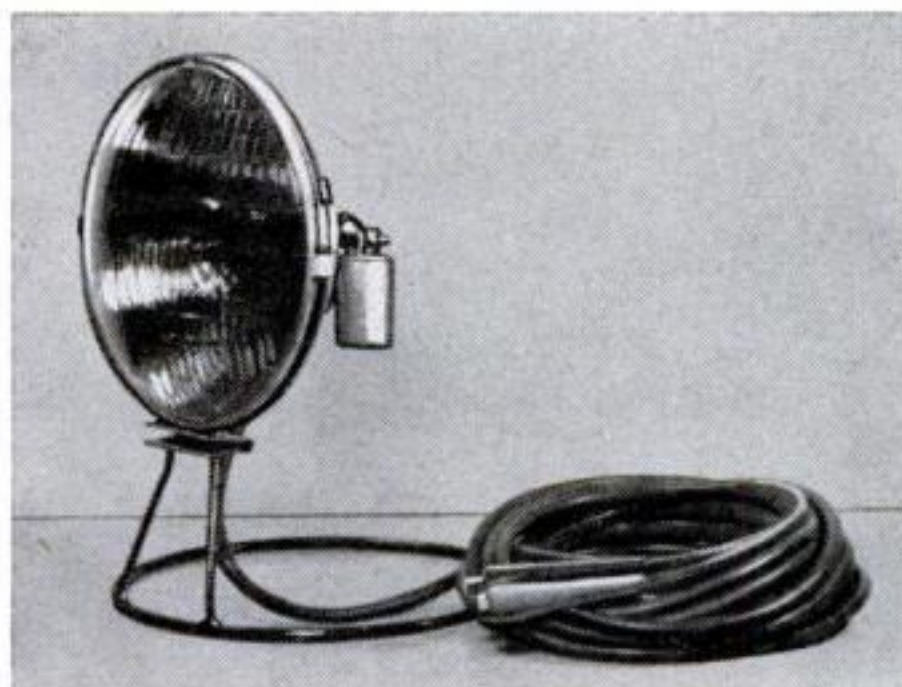
GARDENERS can make good use of paper cups—the rigid, cylindrical kind. Fill them with soil and start vegetable and flower seed in them during the early spring months. At transplanting time, simply cut out the bottom of the cup. No need to disturb roots.—

William B. Egan, Maceo, Ky.

Bins for Storing Small Parts

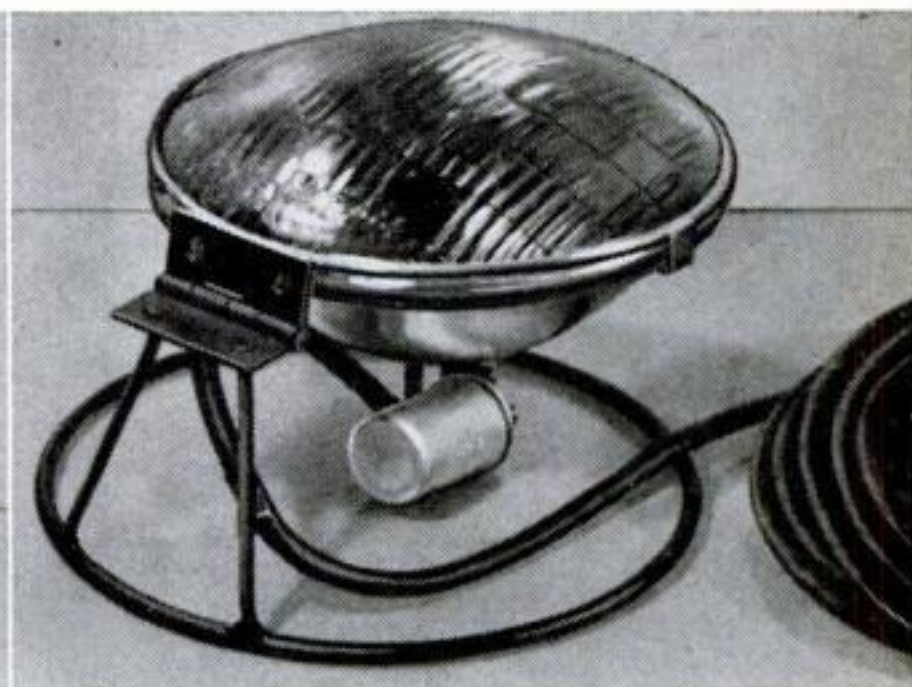
INEXPENSIVE bins for sorting out and storing fasteners and small parts can be made by slicing through one- and two-quart milk cartons about 2" from the bottom and tacking these cup-like sections to a drawer bottom or pull-out slide.—

J. R. Hotz, San Diego, Calif.



Three-Way Emergency Light

THIS simple rig gives me a portable trouble light, a flashing red emergency light, and a spare headlamp all in one. A headlamp is clamped in a wire ring soldered to one leaf of a hinge; the other leaf is soldered to a simple bent-wire stand so the lamp can be tilted. A flasher



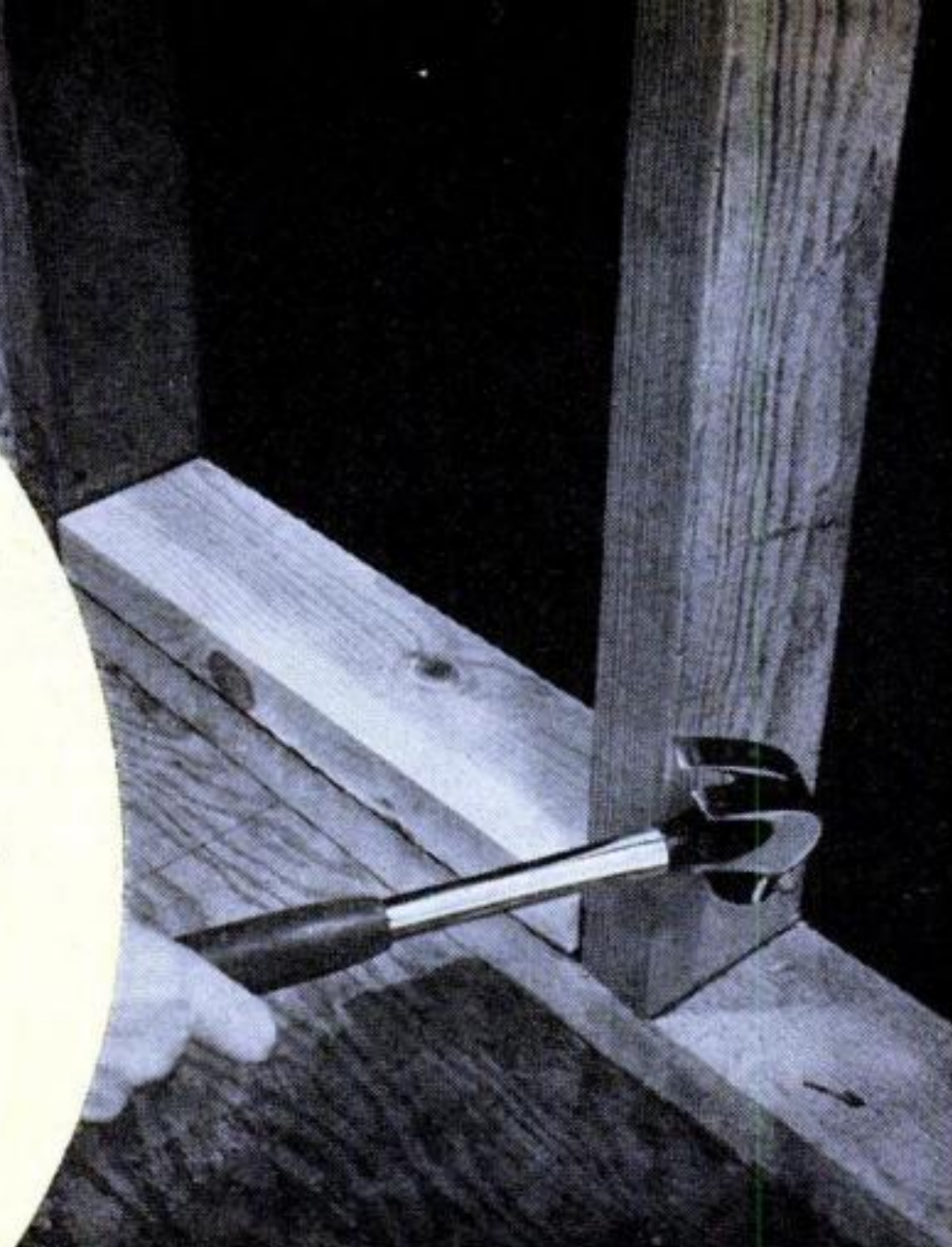
unit is wired to the lamp's terminals with 15' leads.

For use as an emergency light, I cover the lamp with red cellophane and clip the leads to the car battery. For a trouble light, I remove the cellophane and short out the flasher. And when a headlight burns out, I use the trouble light as a spare.—*Robert Micals, Freehold, N. J.*

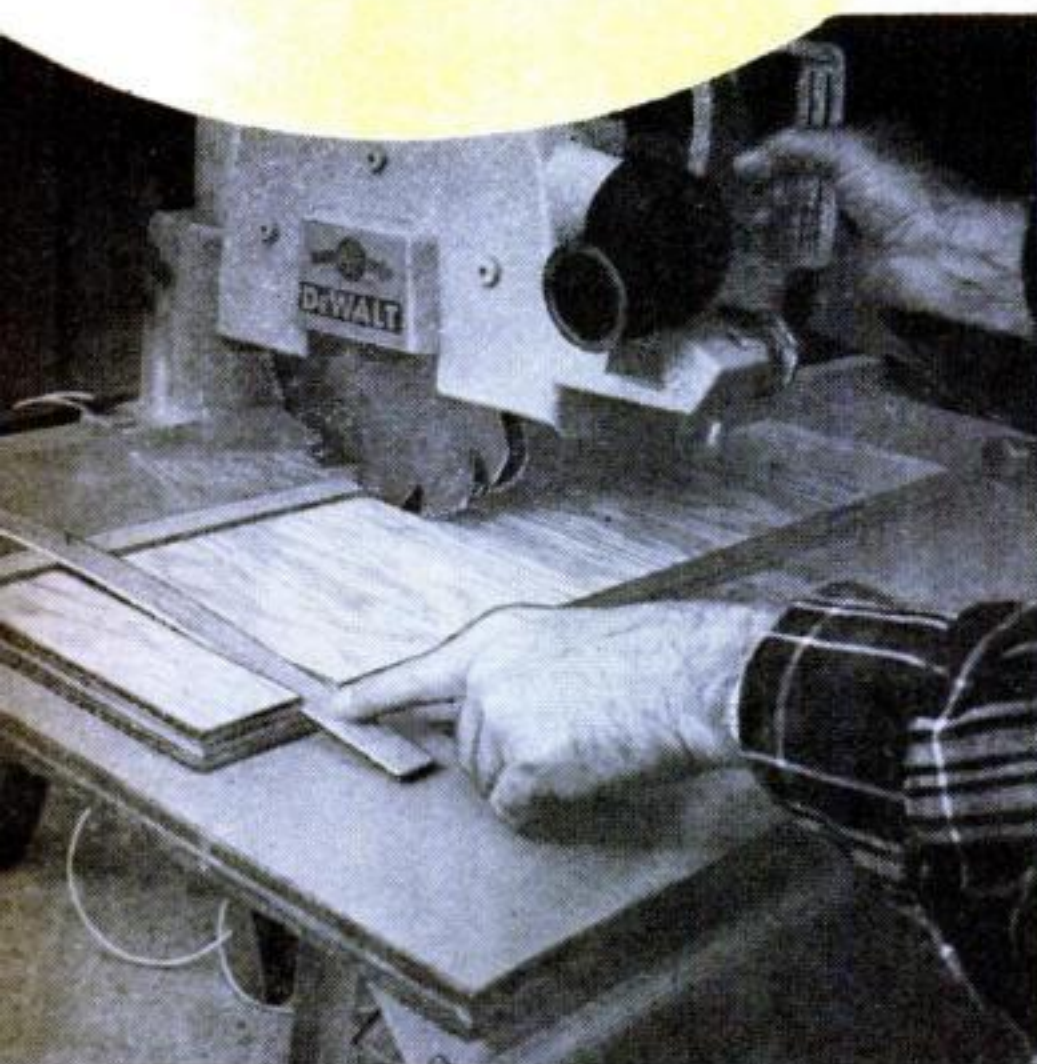
14 Short Cuts to Faster Shopwork

WHY do it the hard way? These tricks get the job done more quickly—and more accurately. The secret? Never translate a measurement into inches or angles where you can transfer it directly to the work. You'll save time-consuming calculations—and the chance of a costly goof.

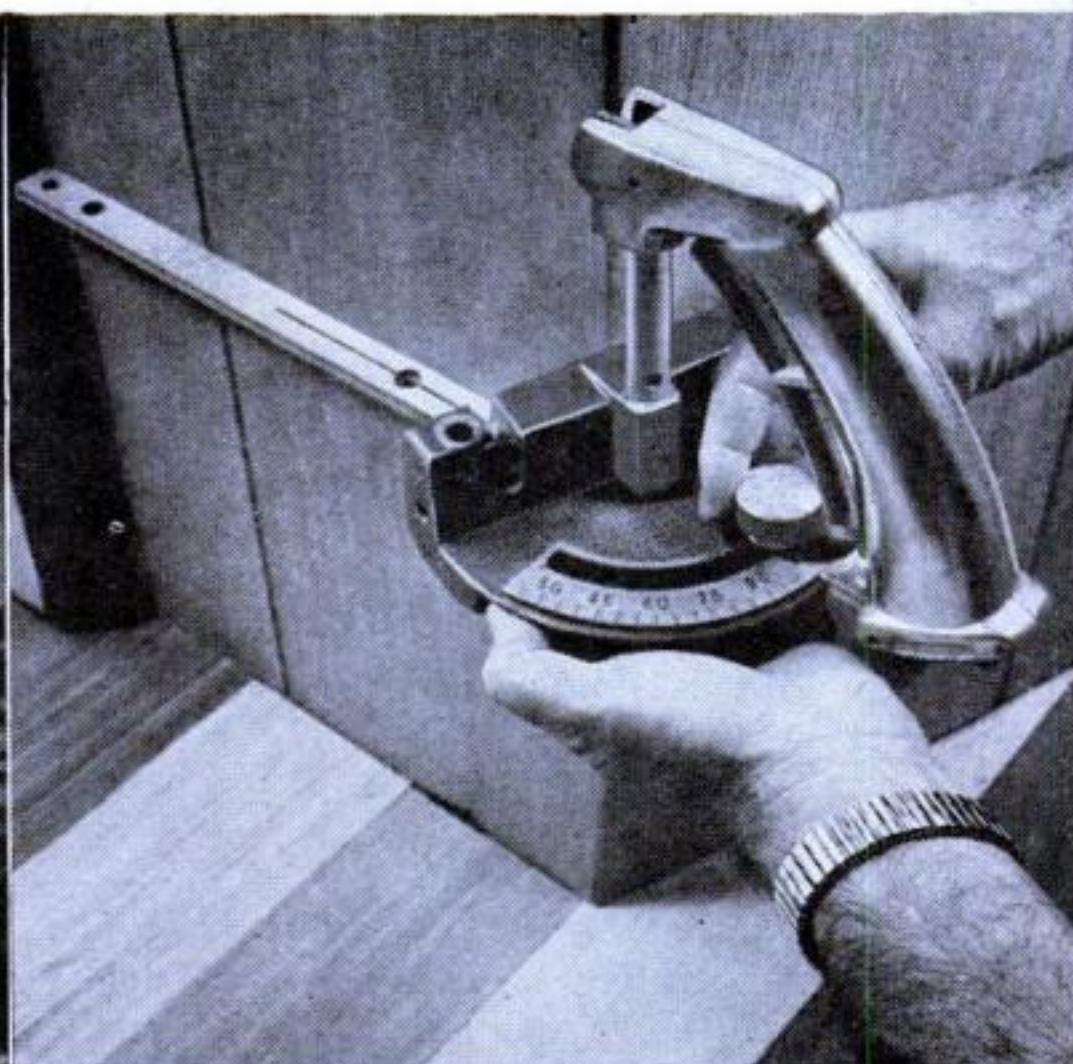
By Darrell Huff



STUDS WON'T SLIP while you toenail them if you back them up with two-by-four gauge blocks cut to the correct spacing. The blocks can be removed and used later for cats or fire stops.



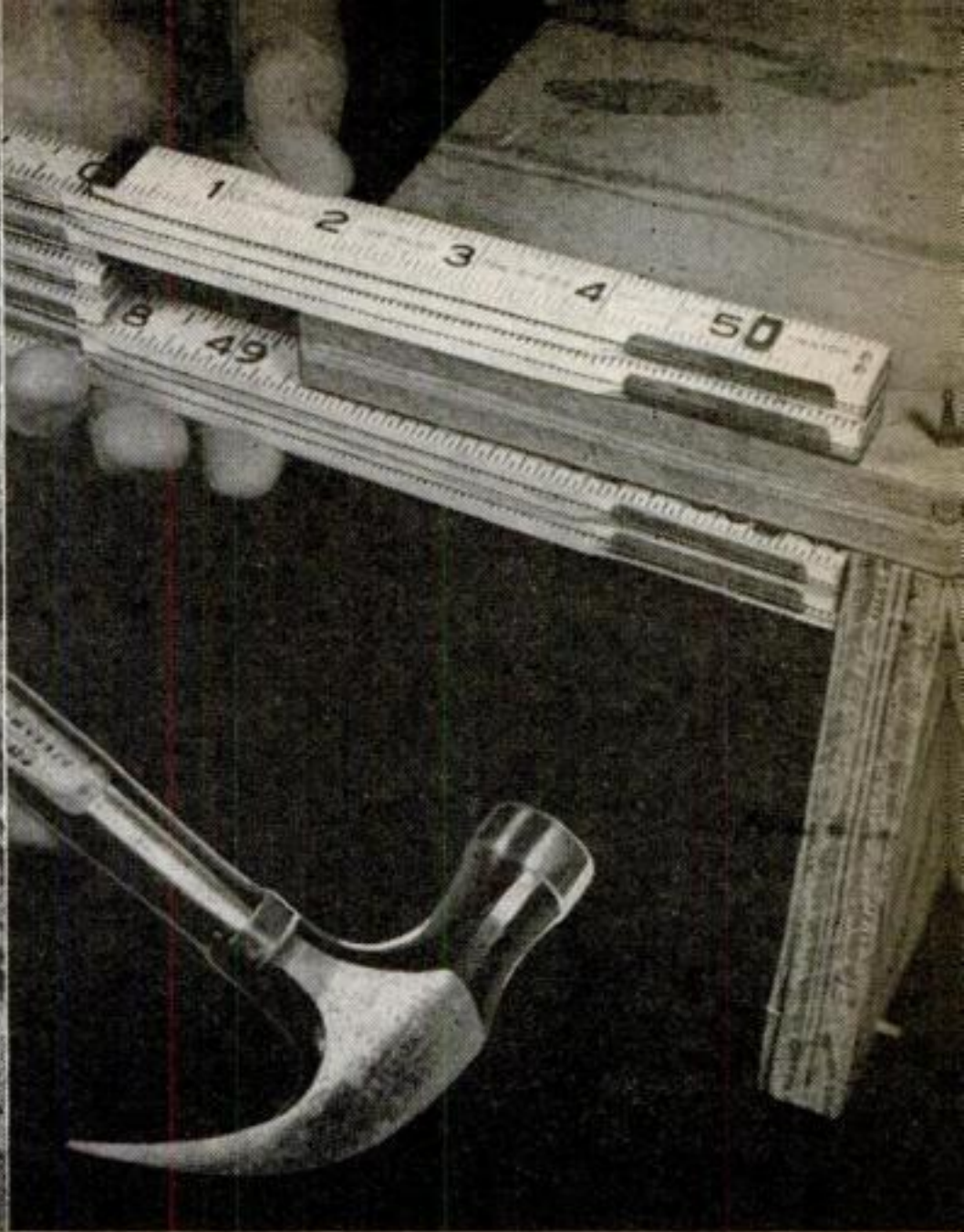
DADOES ARE SPACED AUTOMATICALLY in this setup for making evenly divided bookshelves. A strip of scrap cut to the width of the dado and fastened to the table is pressed into the first cut to line up the second cut. The second cut then lines up the third, and so on.



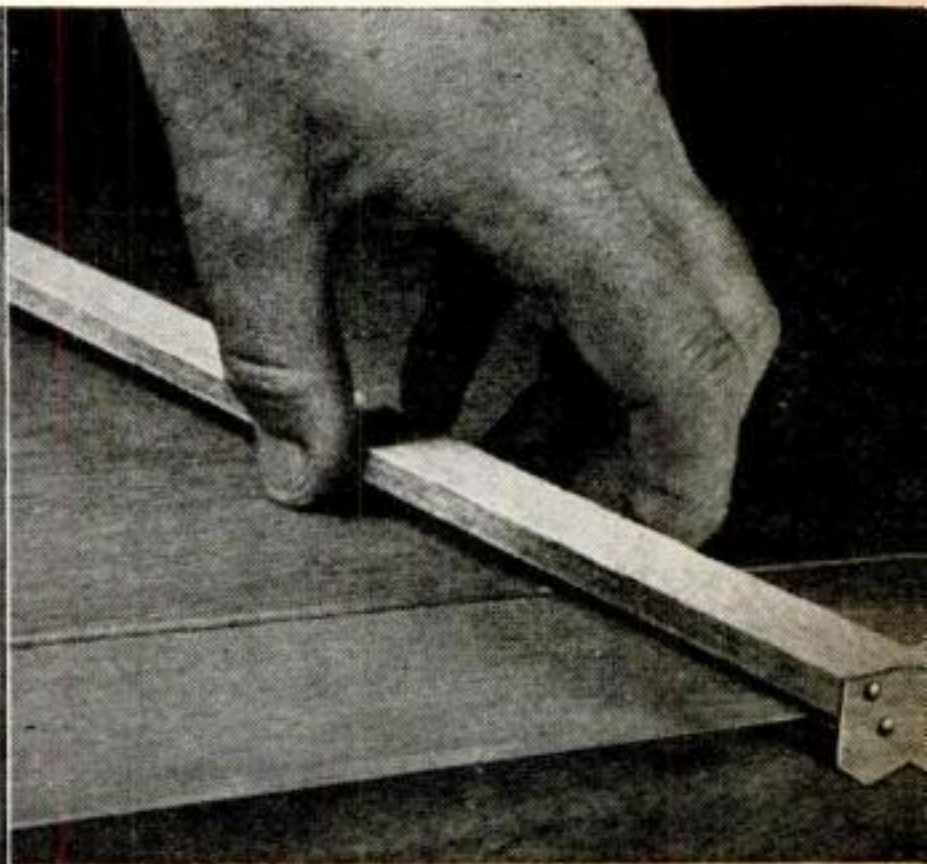
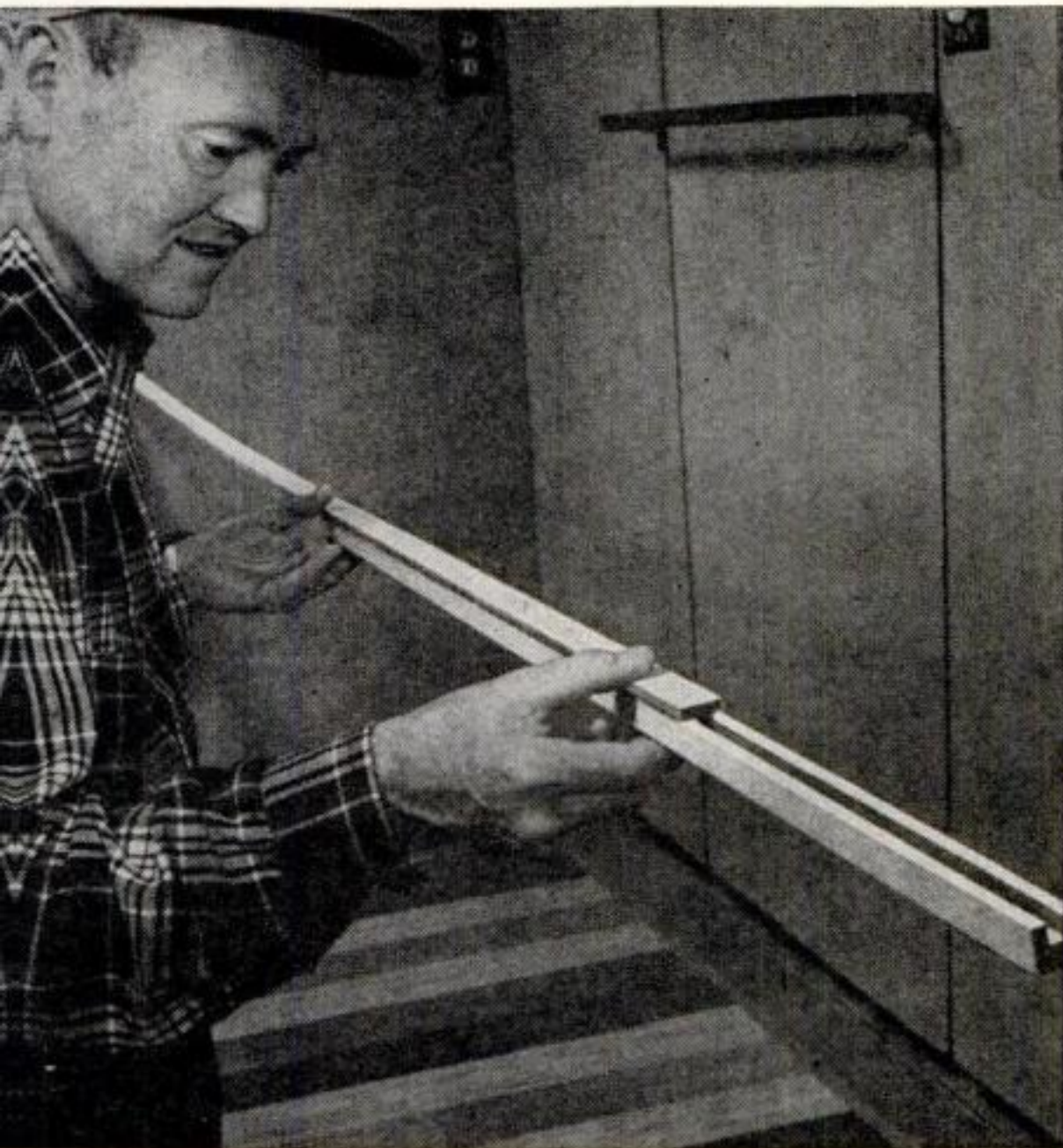
USE A MITER GAUGE to measure angles directly by holding it against them. Then don't even read the angle. Just saw the work with the miter gauge as it's set, or use the gauge to trace the angle onto the work. Even the oddest angles will match perfectly this way.



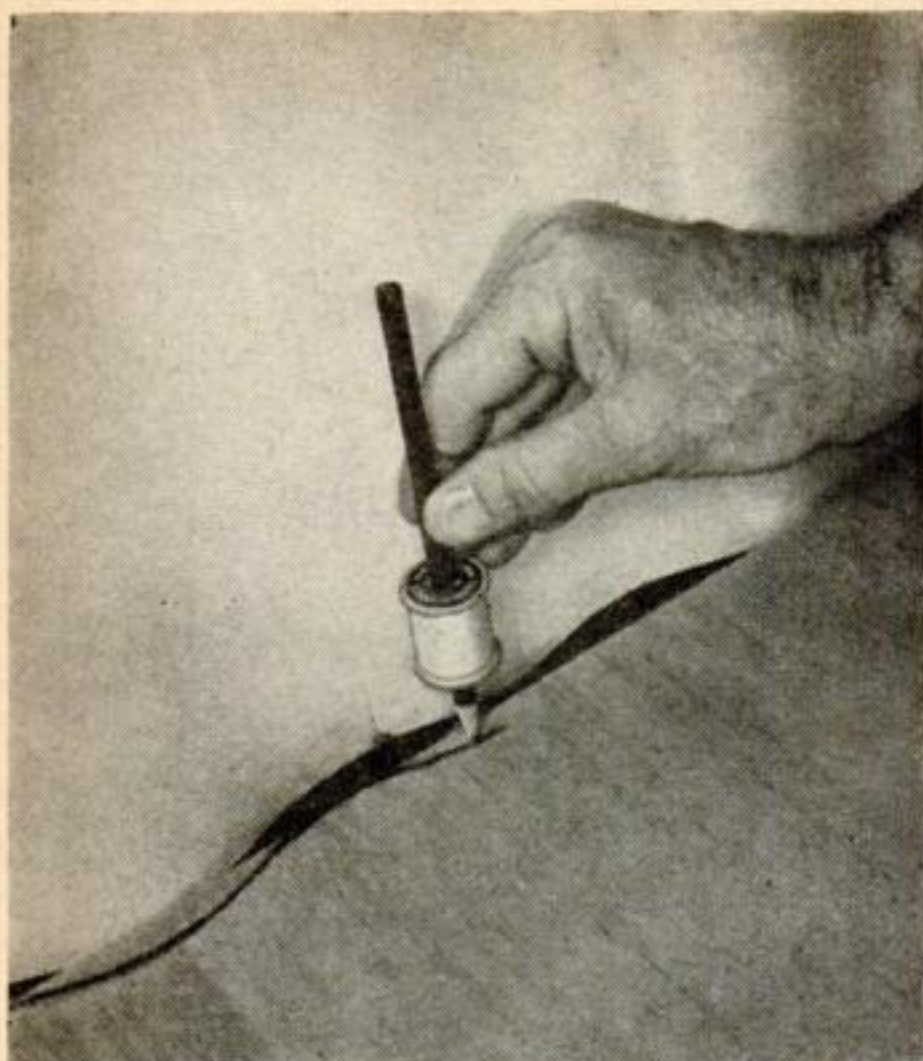
FOR TRACING ROUGH OBJECTS, try an ordinary school compass. Its sharp point will easily follow the roughest irregularities, giving you an accurate copy of the object's profile.



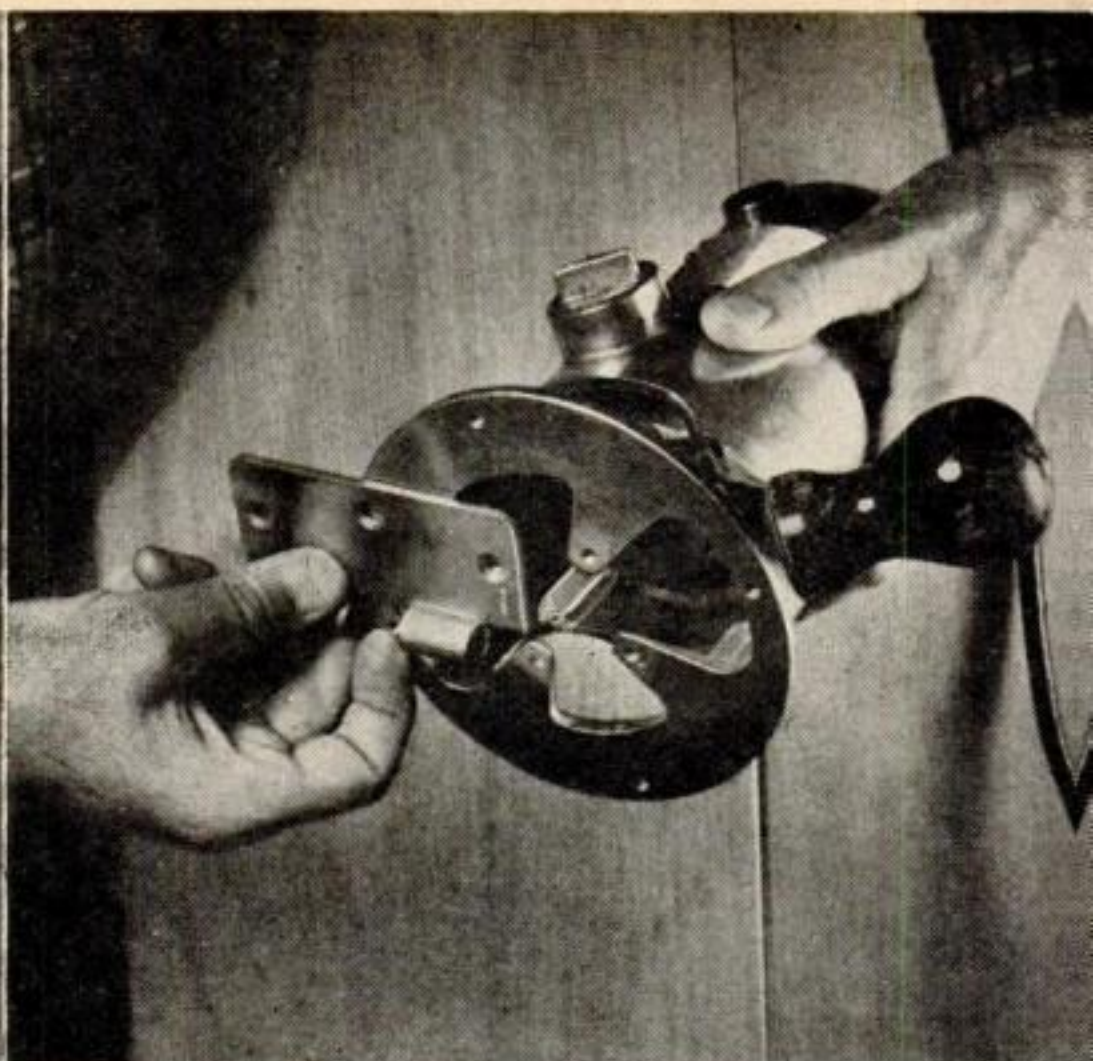
CAN'T SEE WHERE YOU'RE NAILING? Fold a rule so that it straddles the work like this. It will then serve as a quick-reading "feeler" gauge to keep the lower board lined up.



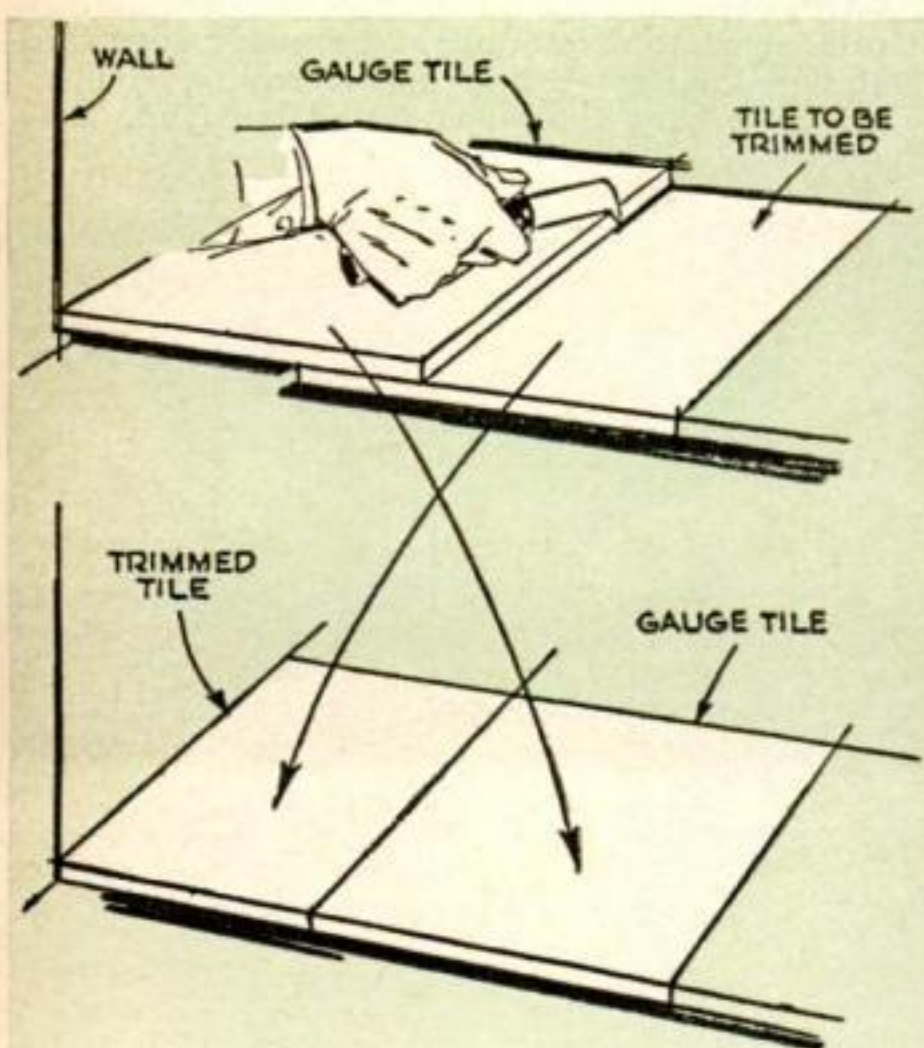
YOU WON'T NEED A HELPER to make big measurements with this aid. Rip a strip off each edge of a tongue-and-groove board and use the two mating tongue-and-groove sticks to form a sliding gauge that can be spread apart for inside measurements, as at left. For outside measurements, tack small metal tabs to the ends to serve as hooks, as above.



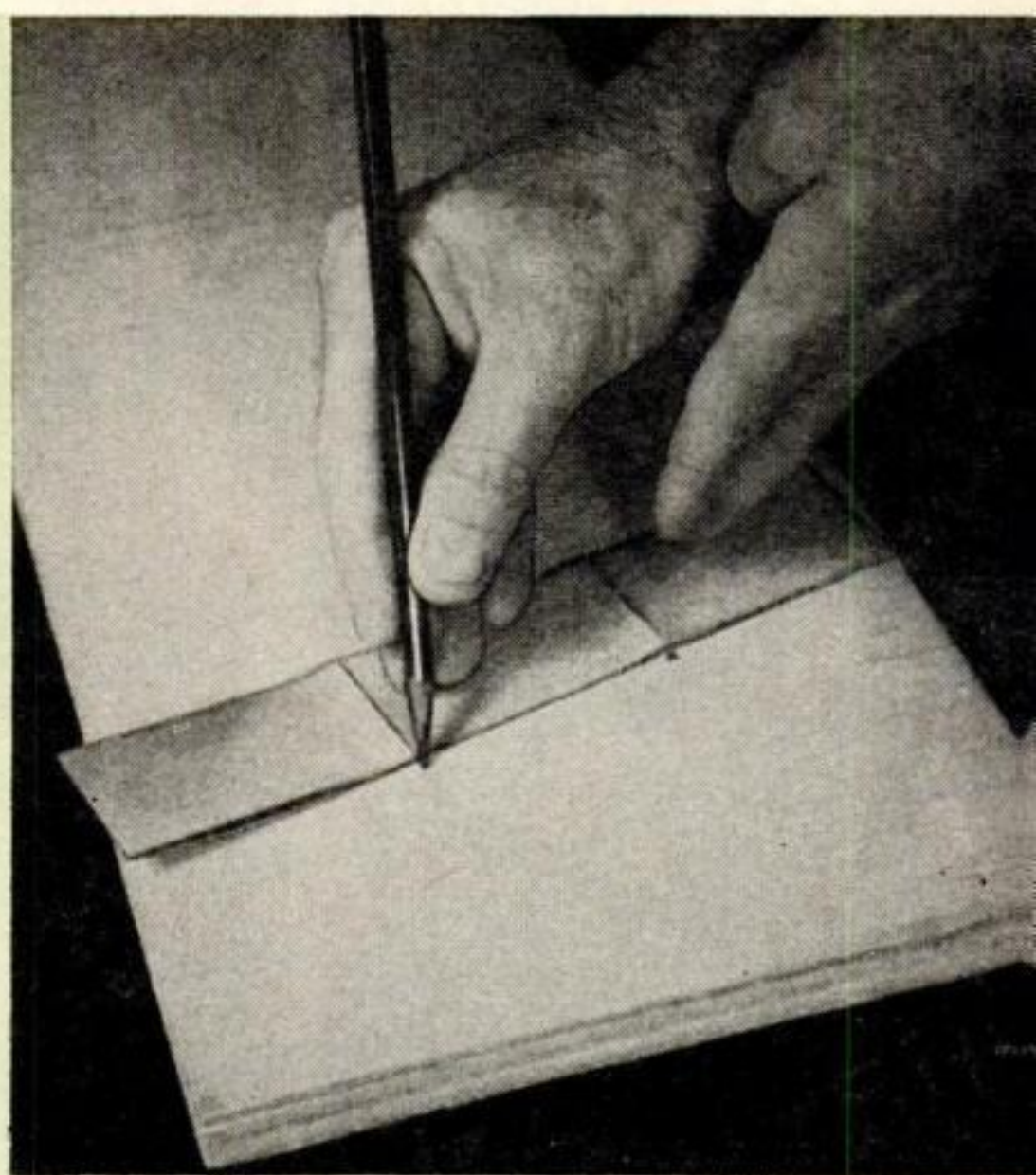
ROLL THIS SPOOL along curves and other irregular shapes, and the pencil will transfer an exact copy of the contours onto your work.



A PERFECT HINGE MORTISE is easy to make if you use the hinge itself as a gauge to set the router bit to the required cutting depth.



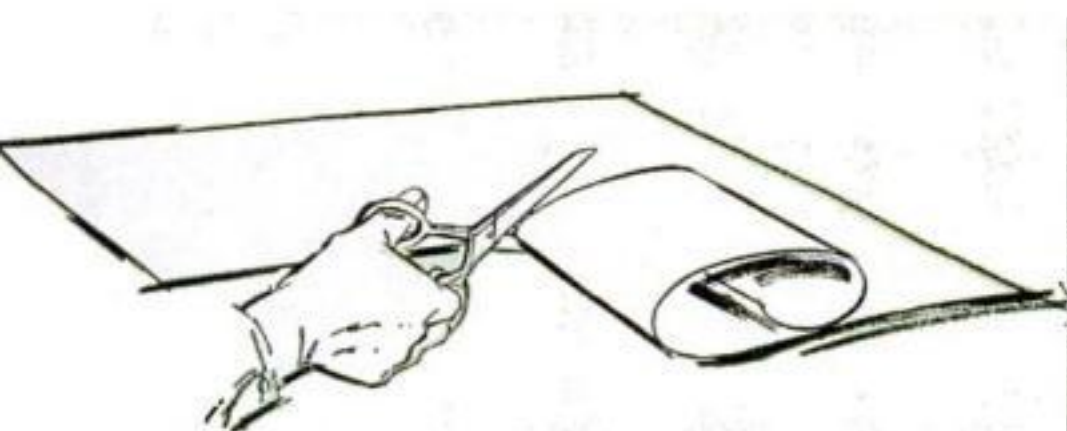
CUTTING FLOOR TILES to fill gaps is faster and more accurate with this professional trick. Instead of cementing down the last full tile, leave it loose. On top of this place another full tile butted against the wall. Score the lower tile with the cutter against the edge of the upper one. The upper gauge tile then becomes the last full tile, and the piece trimmed off the lower tile fits with real professional accuracy against the wall.



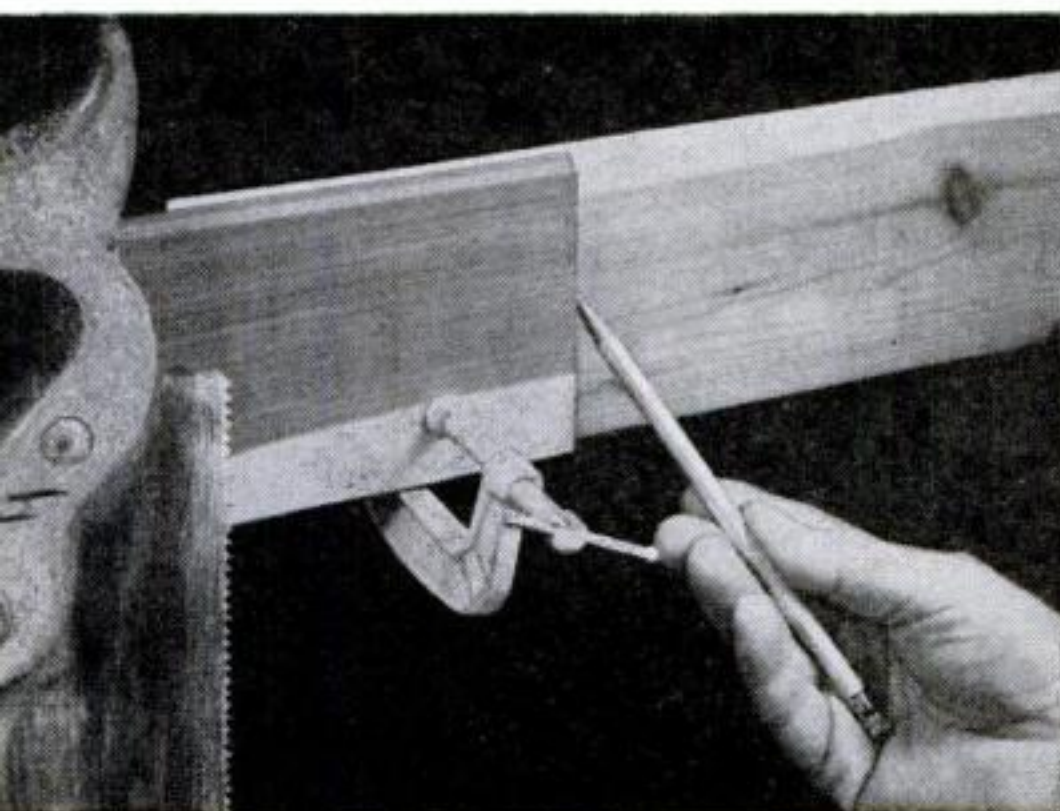
TO RIP A BOARD into equal widths, take a strip of paper slightly longer than the wood is wide, fold it into equal parts—thirds, fourths, eighths, etc.—and lay it across the board diagonally so the ends touch the edges. Marking the board at the fold lines will quickly give you equally spaced divisions.



BEND A STIFF WIRE to match the shape of irregular surfaces where you can't reach in to measure, as above at left. Then use the wire to trace the shape onto your work, as at right.

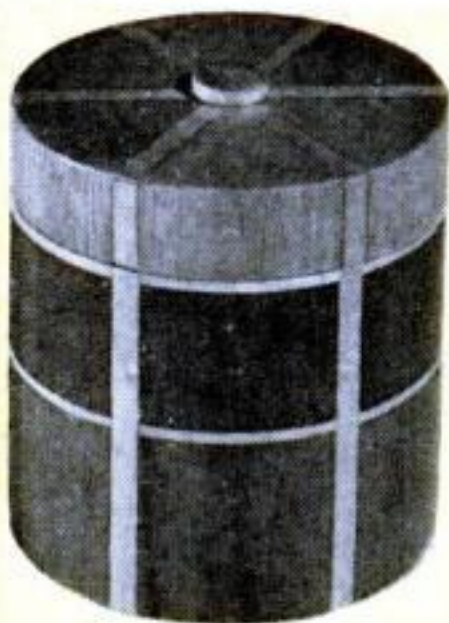


CUTTING FLEXIBLE MATERIALS calls for constant remeasuring to make sure you're on the line. Instead, keep folding the material ahead as you go and let the part you've already cut do the measuring automatically for you.



WHERE A RULER WON'T REACH, you can take the measurement with a compass or dividers like this. Transfer the measurement directly to the work without translating it into inches at all. You'll save time and the chance of making an error.

SAVE FUSSY MEASURING where two or more boards are to be joined end to end. Simply overlap the boards and clamp them so they give the desired total length. Trim off one lap.



Lathe-Turned Jewel Box

By Edwin M. Love

THIS two-tone box is turned from glued-up layers of mahogany wedges. The horizontal stripes are formed by sandwiching 1/16"-thick hexagonal hoops between the stacked wedge assemblies. The top (lid) layer is glued on with a

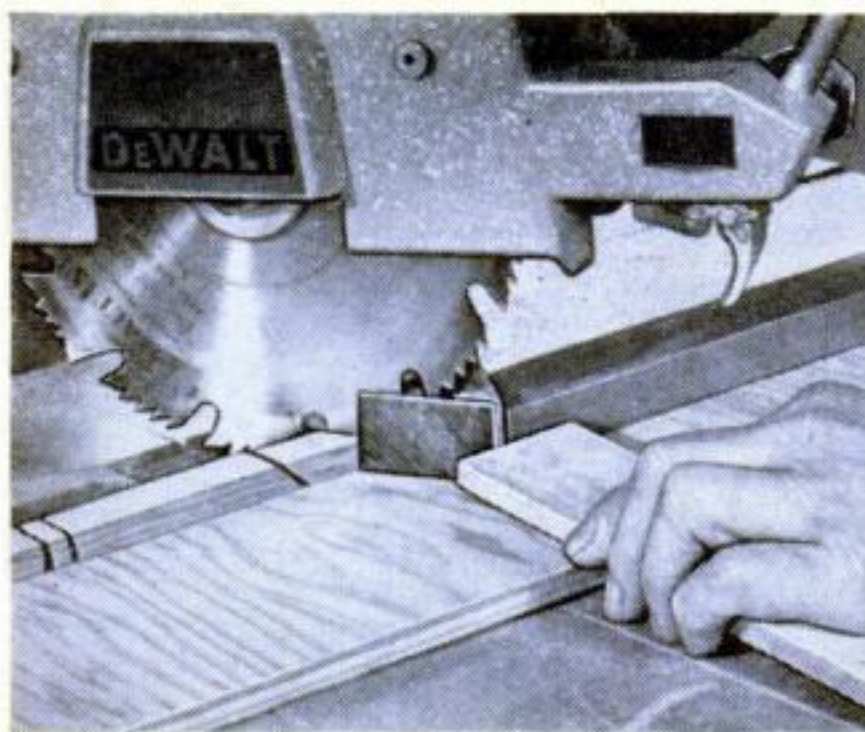
piece of paper between it and the upper hoop so that it can be split off easily after the outside is turned.

Leave the rest of the cylinder in the lathe and hollow out the interior. Next chuck the lid, notch a lip on the lower edge, and gouge the bottom concave.

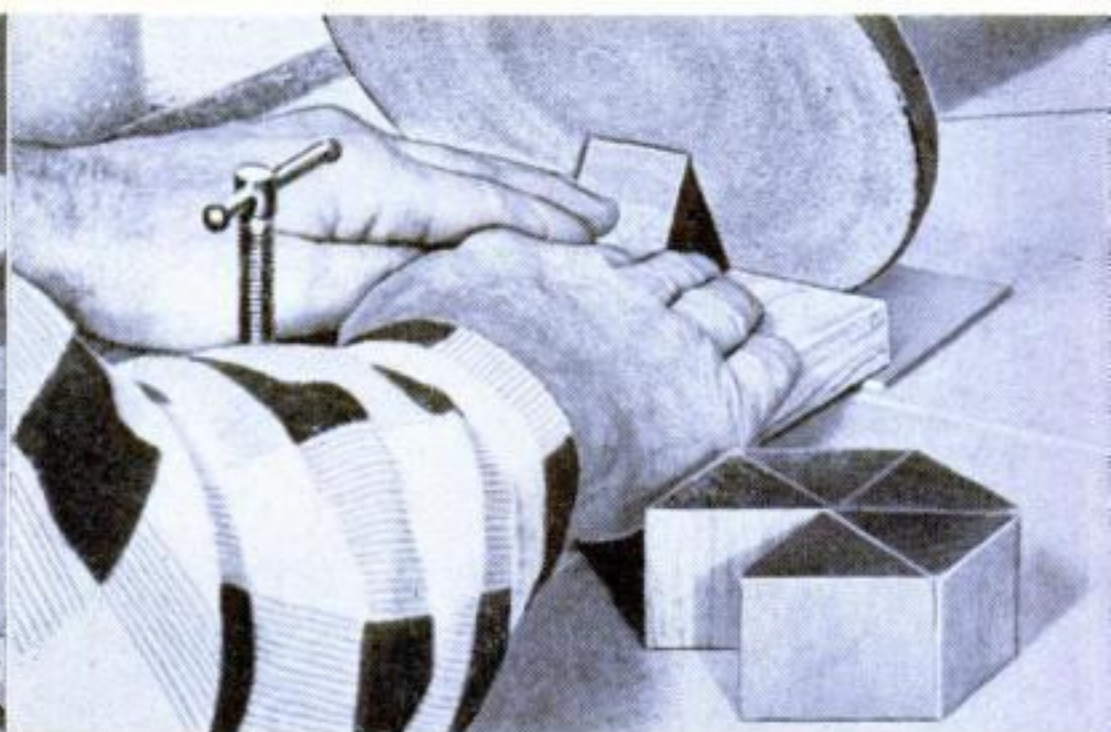
With the lid back in place, secure the finished turning in a bolt clamp made from two scrap blocks bored to take four carriage bolts. As shown in a photo below, clamp the lower block in a vise and cut the intersecting grooves across the top, using the edge of the upper block as a fence to guide the saw. You must, of course, reposition the cylinder in the clamp after each cut.

The lower sketch at right shows the clamp's second position in the vise—for grooving the vertical joints. There will be a center "fin" of wood between the two parallel saw kerfs that determines the width of each groove. Rake this out and smooth the bottom of the groove with the edge of a flat file.

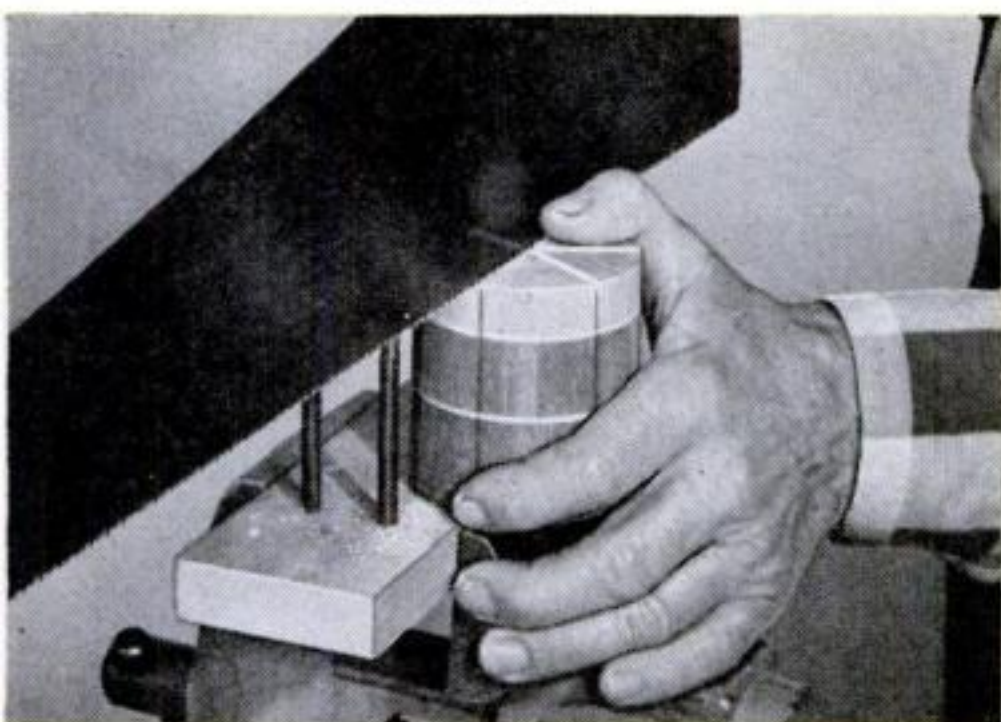
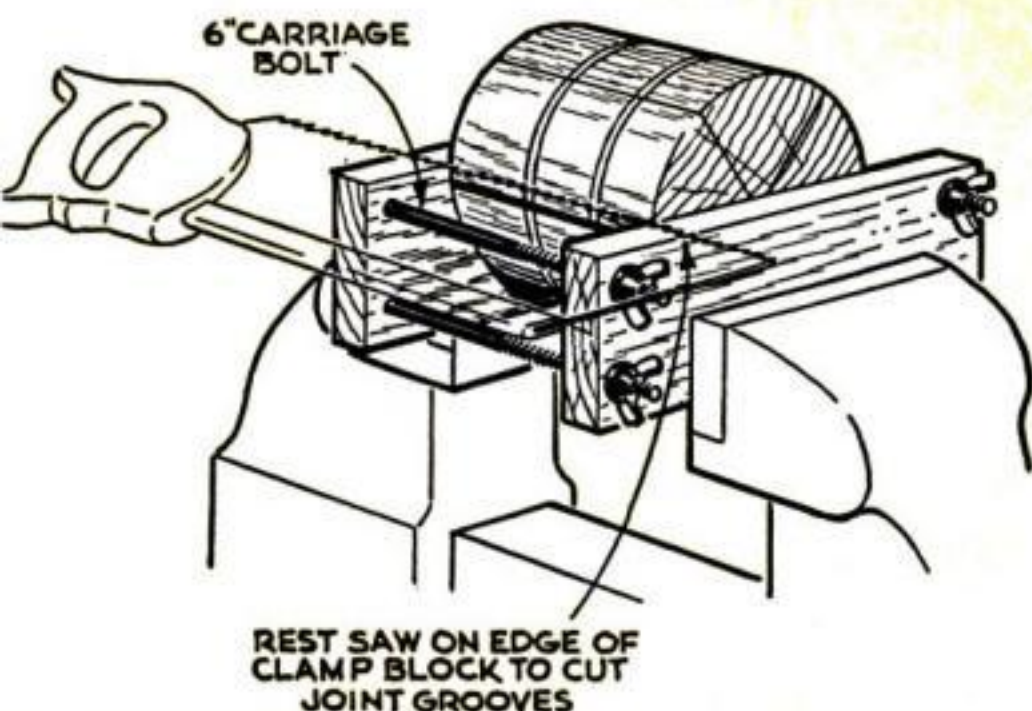
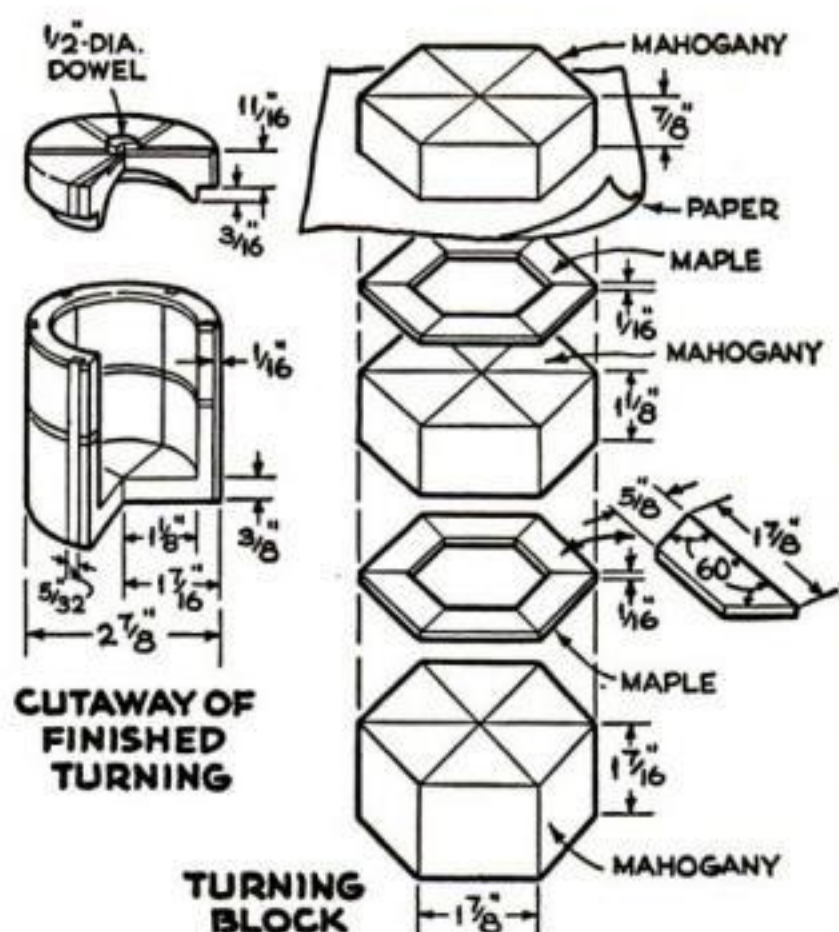
Trim the maple inlay strips to length and glue them into these grooves. Inlay the lid separately. Where the side and top strips meet, miter them to conceal the end grain. The center button is a 1/4"-thick slice from a maple dowel. Glued on to hide the ends of the inlays, it saves tedious mitering. Sand all inlays flush after the glue sets, and apply a clear finish. Rub to a satin texture.



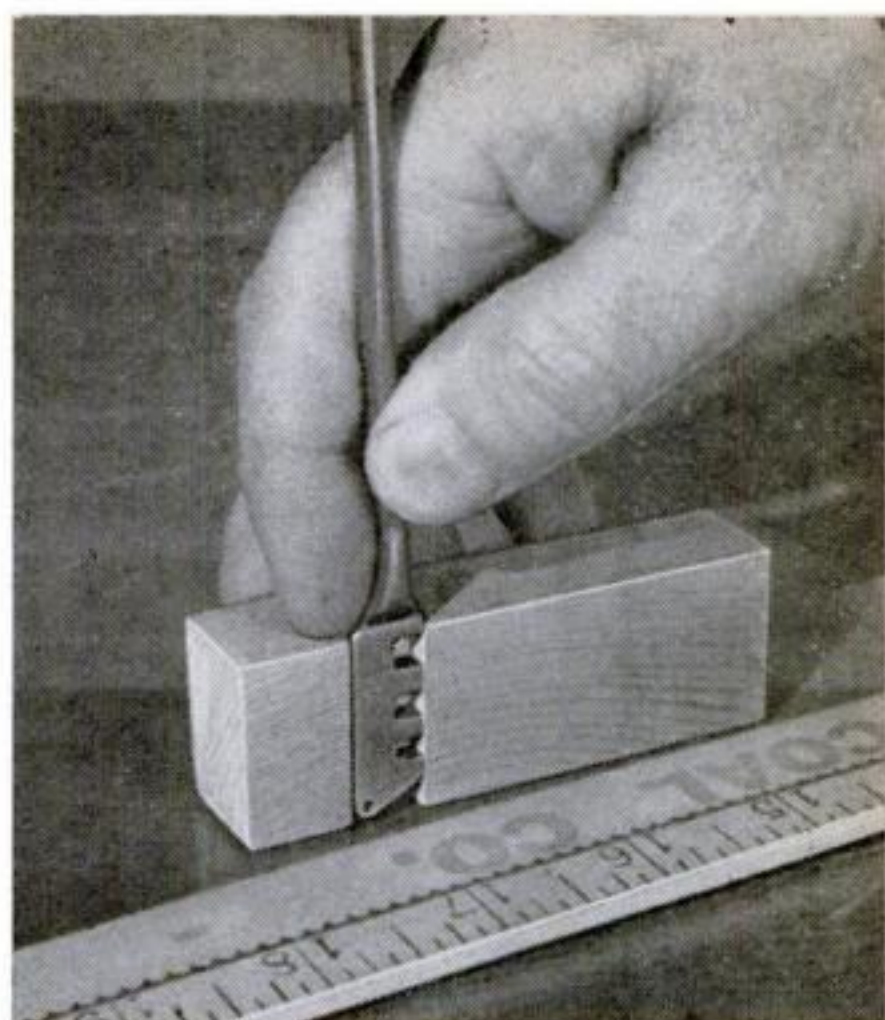
TRIMMING BLOCKS TO SIZE on a radial-arm saw requires a length-gauge strip with one end mitered at 60 degrees. A push stick holds the block against the gauge strip and fence.



SAND BLOCKS FOR ASSEMBLY by tilting disk at angle of cut. Rest final block on board that is shimmed up with piece of thin cardboard to permit adjustment for exact angle required.



GROOVE EACH JOINT between wedges to take an inlay strip, making two parallel cuts a little under $\frac{1}{16}$ \"



Jig Cuts Glass Accurately

A GLASS cutter must be held absolutely straight for best results, but this isn't easy to do by hand. A vertical slot sawed in the side of a small wood block will hold the cutter upright for you as you move it along the surface of the glass.—*Ken Murray, Colon, Mich.*



Old Ring Binder Holds Belts

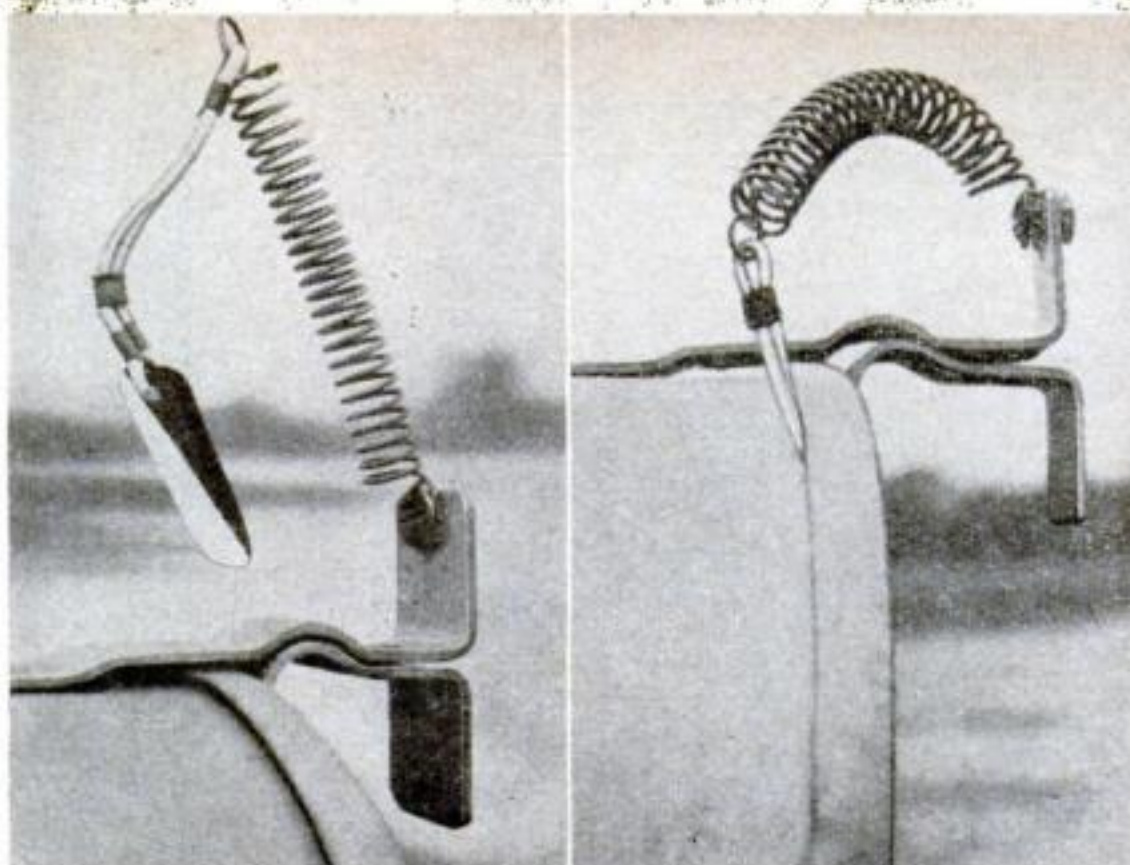
THE metal ring section from an old notebook makes a perfect holder for belts. Remove the rivets and screw the binder to the back of a closet door. A push on the release tab opens all the rings so that any belt can be easily removed.—*Robert Micals, Freehold, N. J.*

Short Cuts and Tips

FROM PS READERS

Signal Saves Trip to Mailbox

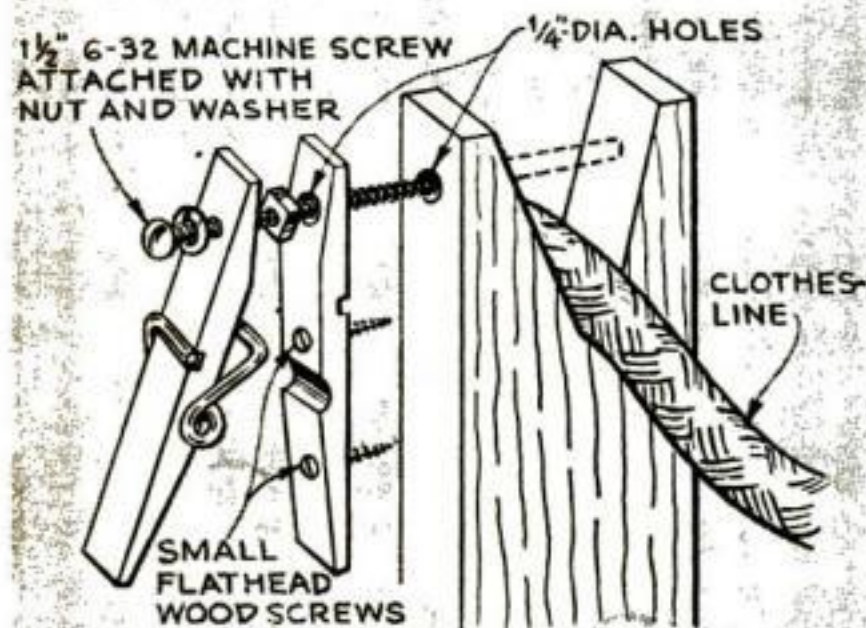
THESE winter days, a glance out the window tells me whether a trip to my mailbox is worthwhile. The signal is a brightly painted metal tag attached to one end of a 4" coil spring. The other end is bolted on the top of the door catch. Each time I collect the mail, I tuck the tag inside. When the mailman opens the door, the tag pops to attention



and beckons me from the fireside.—*Joseph R. Noonan, Burlington, Vt.*

Clip-On Clothesline Pole

WHEN my wife had to re-do a wash because the clothesline blew up out of its notched prop, *she* blew up, too. I calmed her by fixing the prop so it would lock onto the line yet be easy to remove for repositioning. A spring clothespin keeps a bolt across the notch until you press on the free leg. Take the clothespin apart and screw one leg to the side of the pole. Drill a hole through the jaw and on into the notch. Fasten a machine screw through the other jaw before re-assembly.—*Lewis Johnson, Oceanside, N.Y.*

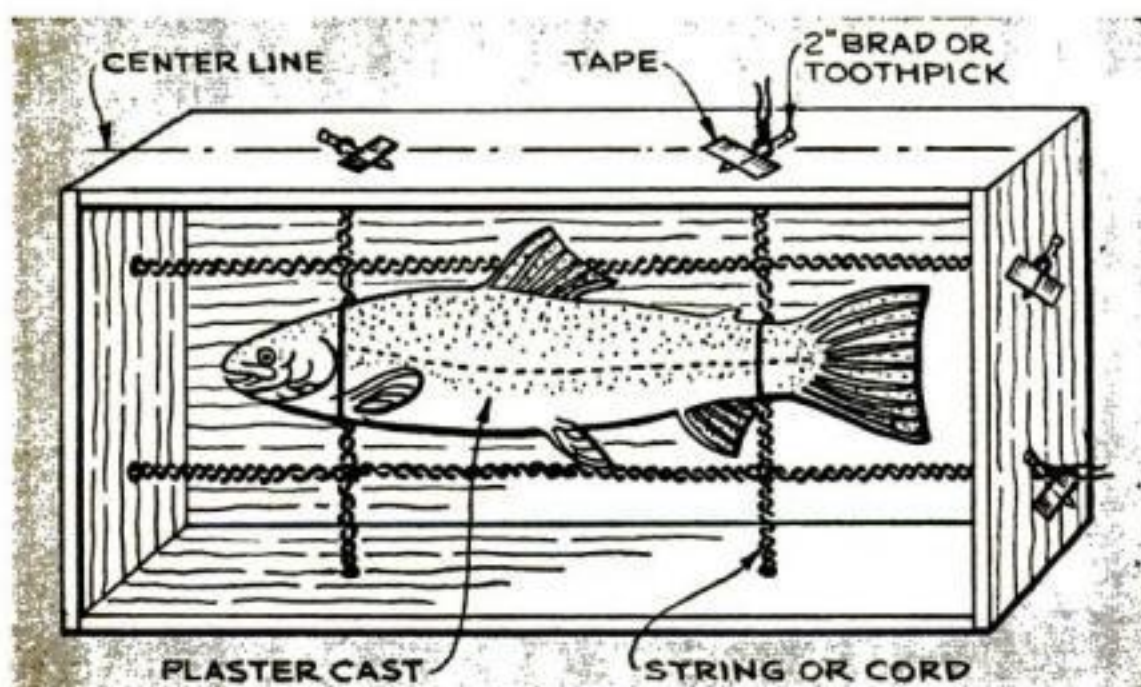


Ship Breakable Items in a Web

SUSPENSION packing has taken many of my plaster casts of fish safely through the mails. It will work for any fragile item that's too irregular for solid pad-

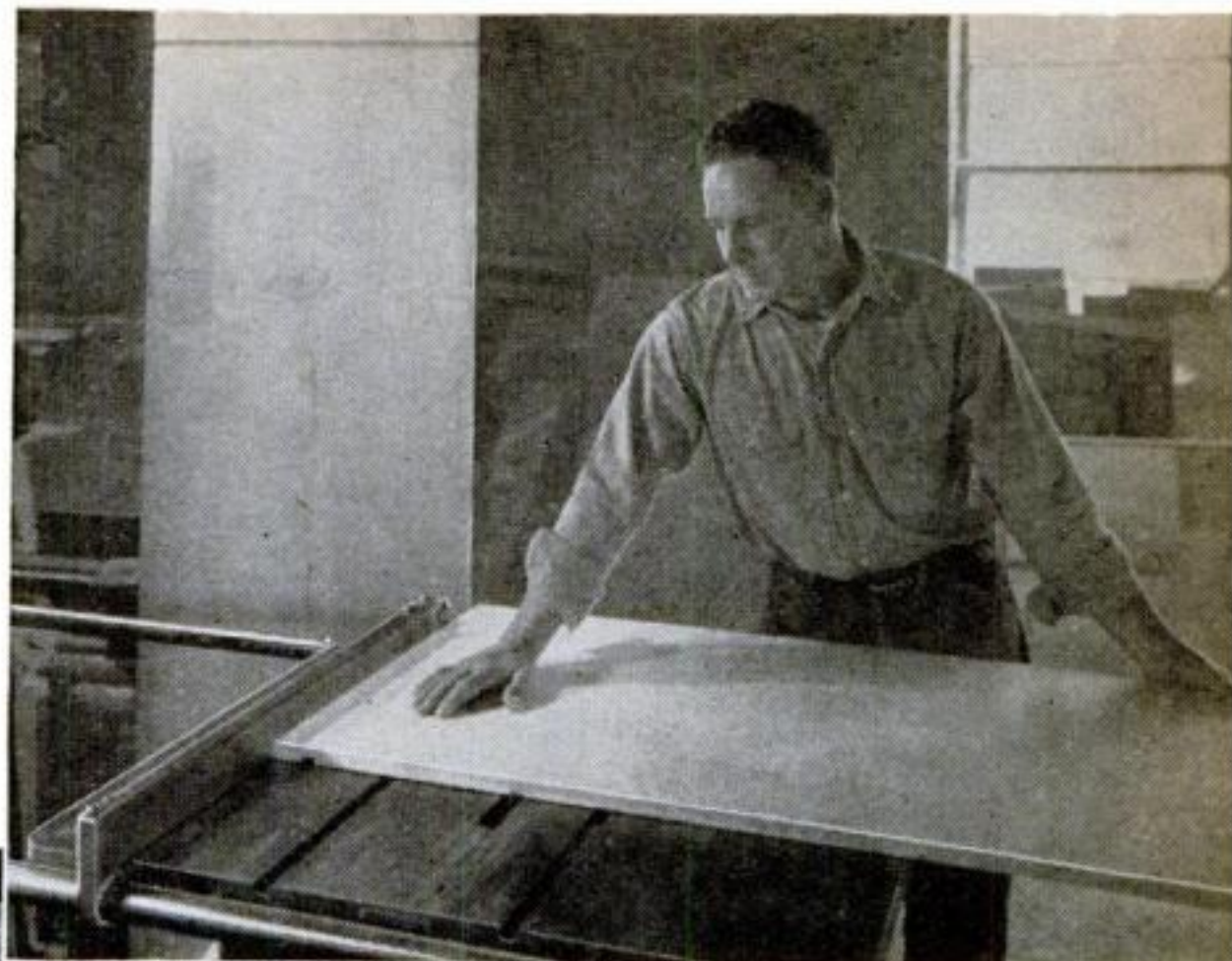
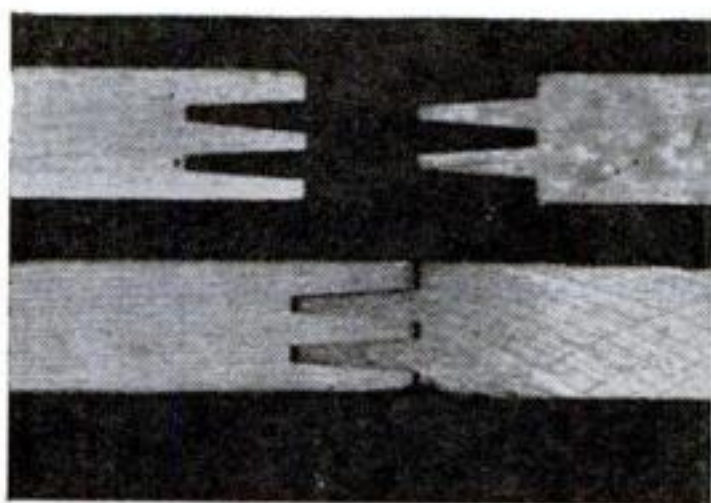
ding, or is so tiny that it might be lost in a tumble of excelsior.

Find a sturdy box, larger in each dimension than the item to be shipped. Draw a center line around the four sides and punch holes opposite one another.



Cut two pieces of cord long enough to cross the width of the box when doubled, with enough spare loop to hold the article. Insert a pin through the end loop on one side and beneath the knot on the other, and twist against the article from both directions. The two horizontal strings are woven through the verticals to form a web that holds the object firm.—*Dr. P. C. Laporte, Edmundson, N. B.*

Solid Wood in Big Panels



BIG PROJECTS ARE NO PROBLEM when you work with large sheets of solid wood like these 2'-wide planks. Wood scraps are glued together with interlocking joints, as shown at left, to make the big one-piece panels.

THE big new panels of solid wood you'll soon be seeing may revolutionize woodworking practices in many shops. You'd do well to know what they're good for, how well they work, and how you can buy them.

Imagine what you could do with sheets of solid wood up to 24' long and 54" wide. That's what you get with a product aptly named Widewood. The giant boards are made by edge-gluing hundreds of small wood scraps—some as narrow as 2"—into big one-piece panels.

The result is a product that has advantages over both regular lumber and plywood. The boards won't warp, cup, or crack, even in the largest sizes, as will individual planks. Yet, being solid wood, they are easier to saw and shape than plywood, have no problem edges to conceal, and have a fine, straight grain that takes paint and natural finishes well.

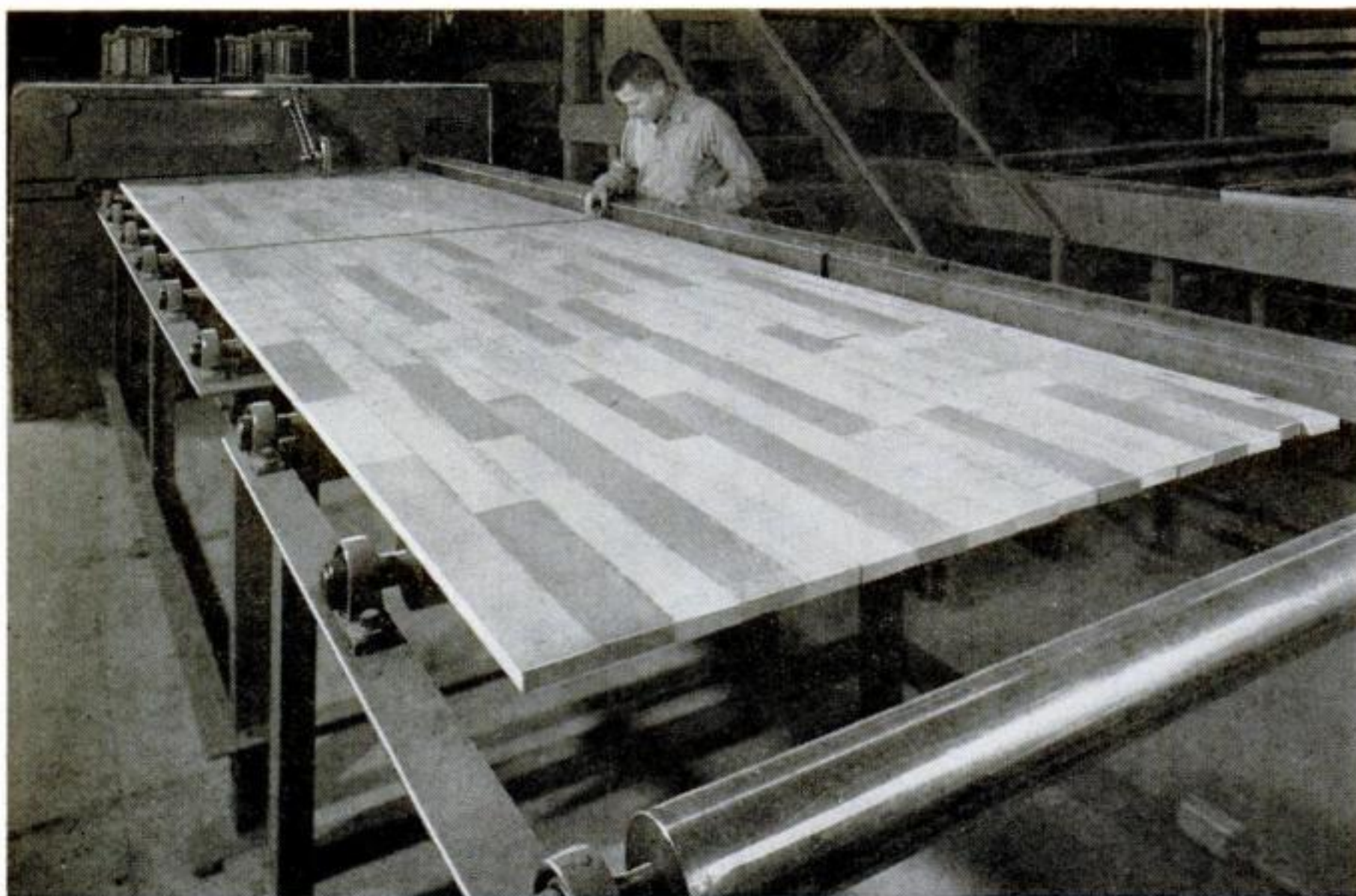
What's it good for? Widewood is ideal for cabinets, built-ins, furniture, and other large areas because it eliminates joints and gives you a smooth surface. Since it comes in a wide range of sizes, you can buy it to match the job with less waste.

You can nail or screw directly into the solid edges without the fastenings loosening, or you can leave edges exposed with no special treatment. Because the wood is stable and flat, it's also good for doors, counters, and table tops. There's no prominent grain to show through thin plastic counter coverings.

How you buy it. Widewood is sold in all common lumber lengths up to 24' and in widths (actual) of 12", 16", 18", 24", 36", 48", and 54". Nominal thicknesses are 1", 1¼", and 1½". Thicker slabs up to 4" are available on special order.

Widewood is made of ponderosa pine in three grades: Clear, which is B-grade lumber or better; Selected, which is No. 1 and No. 2 Common lumber; and Common, which is No. 3 and No. 4 Common. Clear grade, which is completely free of knots, sells for 50 cents a square foot in the 1" (¾" actual) thickness. Selected grade, which has small, tight knots, is about 27 cents a square foot in the same thickness; Common grade is still less.

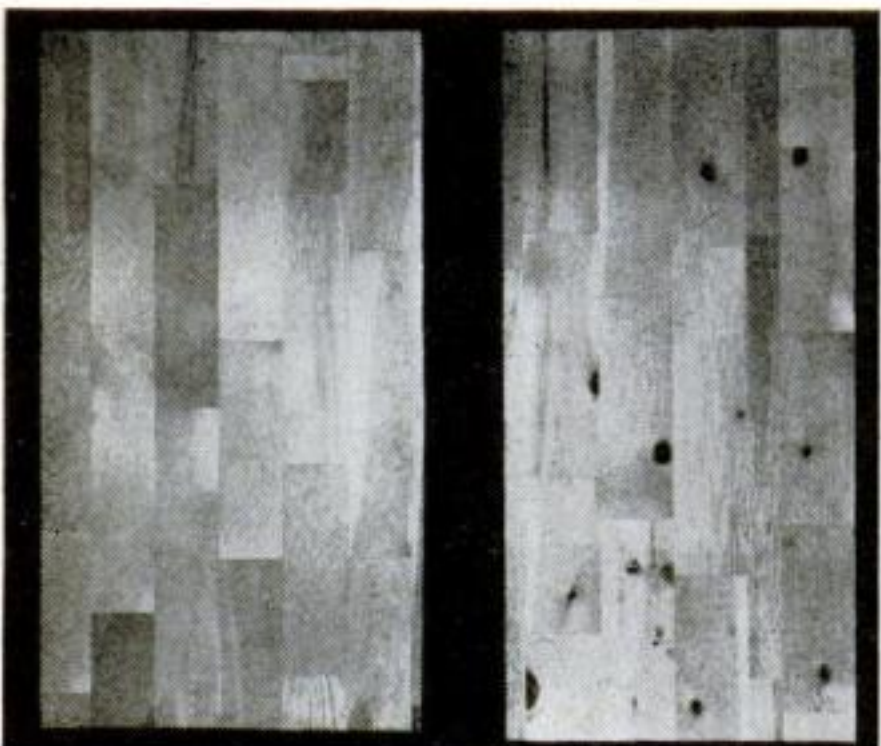
At these prices, Selected grade Widewood is a little less than a comparable grade of plywood, and Clear grade is somewhat more. In Clear grade, however, you get the advantage of smooth, straight grain, which is easier to finish than rotary-cut plywood. In addition to pine, Widewood is also available on special



THIS IS A SINGLE PANEL 54" wide and 24' long, one of many supersizes of solid lumber made by assembling small wood scraps. It's shown here leaving the electronic gluing machine.



IT LOOKS LIKE LUMBER—but it's better for many uses. Glued-up panels won't warp or twist like boards. Edges need no special treatment.



YOU GET CLEAN, STRAIGHT GRAIN in the Clear grade above at left. The less-expensive Selected grade at right has small, tight knots.

order in Douglas fir, larch, or white fir.

How it's made. The pine scraps in Widewood aren't just sweepings off the floor. They're selected from high-quality, slow-growth Oregon timber. The wood is first kiln-dried to make it shrinkproof and to eliminate stresses that later lead to warping, twisting, and cupping. It's this process, plus the combination of many small pieces, that make the panels flat and stable.

The scraps are held together by multi-fingered, interlocking joints at the ends and are electronically glue-welded under 3,000 pounds' pressure and high heat. The glue, a special blend of melamine and urea, is colorless, waterproof, and stronger than the wood itself.

Widewood is made by the Edward Hines Lumber Co., 200 S. Michigan Ave., Chicago. It can be obtained at lumber yards in the East, South, and Midwest and will soon be available in the Far West. A few types of similar built-up lumber are being made by other companies, but these are now available only to builders and industrial users.

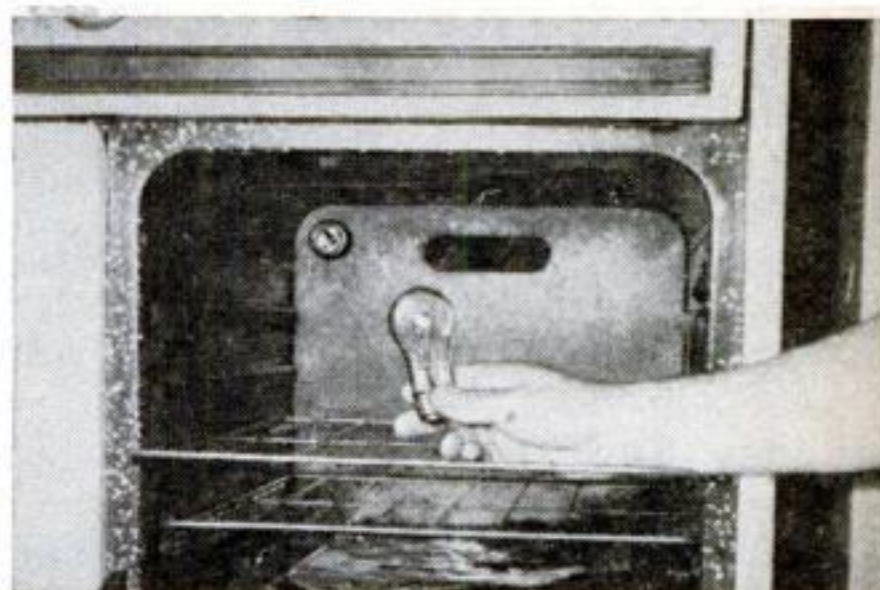


New Faces for a Lead Hammer

HERE'S a lead hammer that can be restored when the lead faces become worn. It's a pipe tee fitted with a handle. Replaceable faces are made by casting lead in another threaded fitting used as a mold. Pack the fitting with steel wool up to the threads and insert a disk of asbestos paper to hold in the lead. Wire a strip of asbestos around the outside of the fitting to form a cup and pour in molten lead. When cool, the lead faces can be unscrewed from the mold and screwed into the hammer as they're needed.—Robert Micals, Freehold, N. J.

Short Cuts and Tips

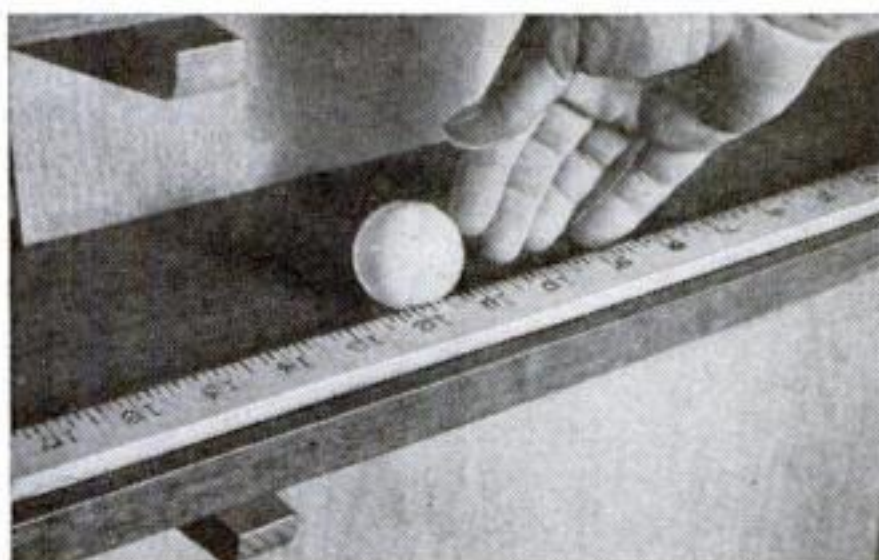
FROM PS READERS



Replacing an Oven Light

IF THE light bulb in your oven burns out, replace it with one marked "range oven." These special bulbs are made of heat-resistant glass and are fastened at the base with high-temperature cement. An ordinary bulb will come apart or shatter when subjected to oven heat.—Robert Hertzberg, Douglaston, N. Y.

▶▶▶EXTRA handles for files and rasps can be salvaged from a child's worn-out jumping rope. Just cut the rope flush and drive the handle onto the tang.—Arthur R. Tanner, Poughkeepsie, N. Y.



A MARBLE or steel ball will serve as a makeshift level. Place it against a straightedge to keep it from rolling off, and adjust the shelf until the ball remains stationary. The same tip applies

What Would You Do ?

... with a shelf to
put up and no
level at hand

when you want to test for a level sub-floor before laying down the finished flooring, or to check the floor of a house you're thinking of buying. In these cases, omit the straightedge.

Darrell Huff, Pacific Grove, Calif.

Short Cuts and Tips

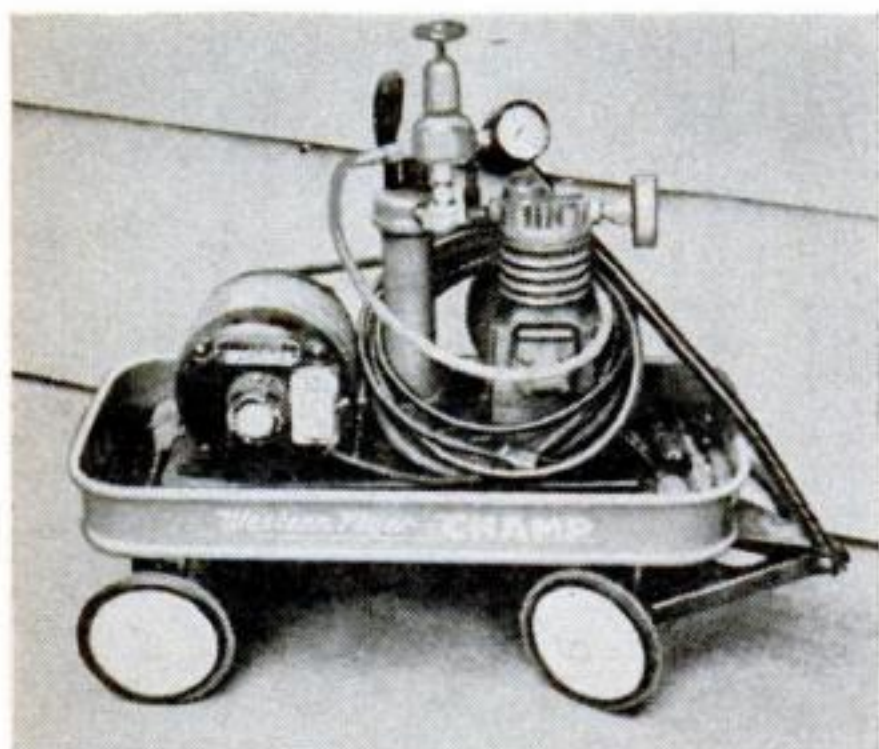
FROM PS READERS

Corral for Indoor Marble Game

WINTER days mean indoor play. The kids need an area for a game of marbles on the rug. A length of armored cable with the ends joined will fence it in to keep the marbles from straying. Clean the cable and cover the

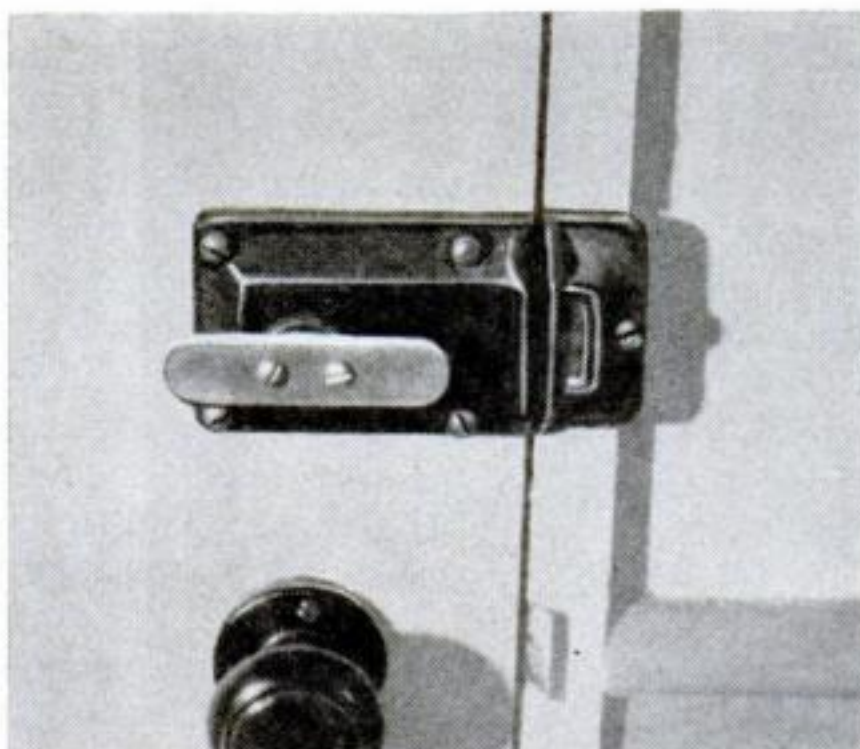


splice with tape. To store, twist the ring to form a figure eight and fold it double.
—J. E. Russo, Portsmouth, Va.



Wheels for a Compressor

I MADE my spray compressor portable by mounting it in a child's wagon, after equipping it with a long heavy-duty cord. Compressor and motor are fastened to a wooden platform. Four bolts attach this unit to the wagon bed, leaving room for carting tools, too.—O. G. Newby, Houston.



Bar Signal for Night Latch

OKAY, so I'm lazy. But I got tired of having to cross the room to check whether the back door was latched. By adding an aluminum bar to the knob, I made it easy to tell from a distance, come bed-time. When the latch is off, the bar is vertical.—A. Walker, Hemet, Calif.

Wrench is Substitute Clamp

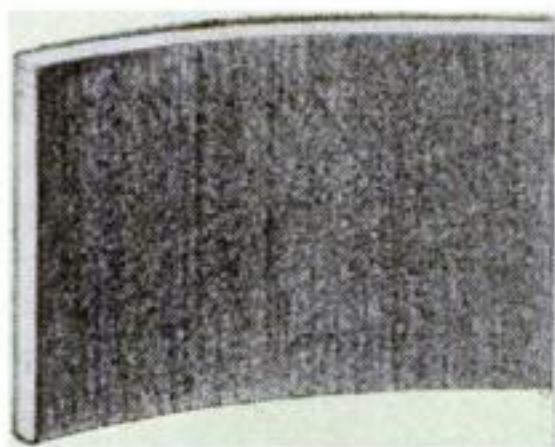


I OWN a couple of big C clamps, but when I need them they always seem to be in use—or mislaid. Last time this happened, I clamped on a pipe wrench instead, padding the jaws with scrap blocks. Its jaws will handle many jobs.—Jack Clark, Canary Islands, Spain.

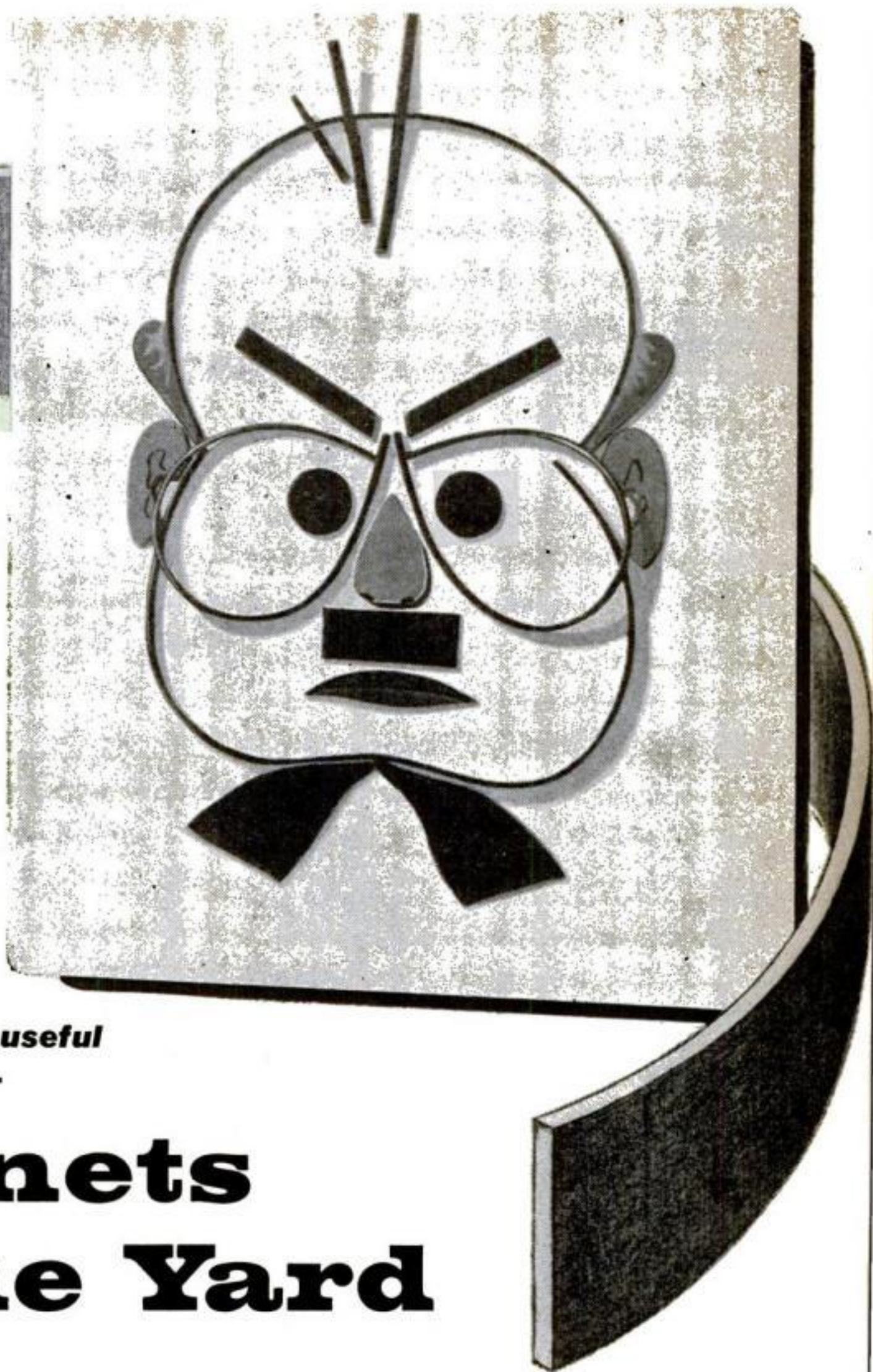
Seal the Paint-Can Groove

THAT groove around the top of a paint can is neat and clean when you first pry the lid off. You can keep it that way—and avoid the poor seal and the messy spatter when you replace the lid—by seating a rope of calking compound in it.—Roger Samuels, Commack, N. Y.





ANYBODY CAN CARTOON a thousand funny faces with bits of magnetized vinyl tape on a sheet-iron board. It's only one use for an exciting new material. For more on this, turn the page.



Wacky, weird, and useful things to do with—

Magnets by the Yard

By Harry Walton

SOMETHING new in magnetic materials is a dark-brown vinyl tape about $\frac{1}{16}$ " thick. When you pull one strip along on top of another, the top one bounces as though crossing invisible railroad tracks. If you slide it with finger pressure, it feels as if there are cogs between the two pieces.

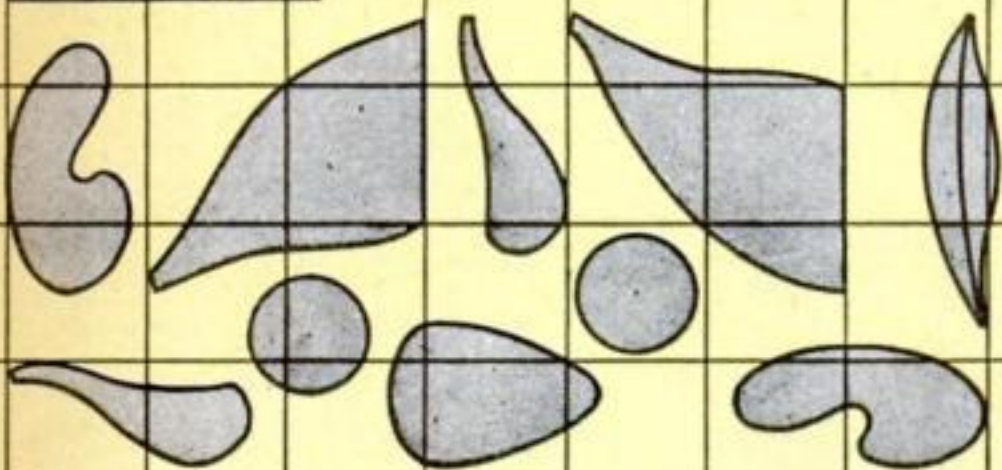
These cogs are parallel magnetic poles.

The tape is loaded with magnetized particles. You buy the 1" width by the roll—3' for less than two dollars. You can cut it with a knife or scissors, bend it, paint it, attach it to just about anything.

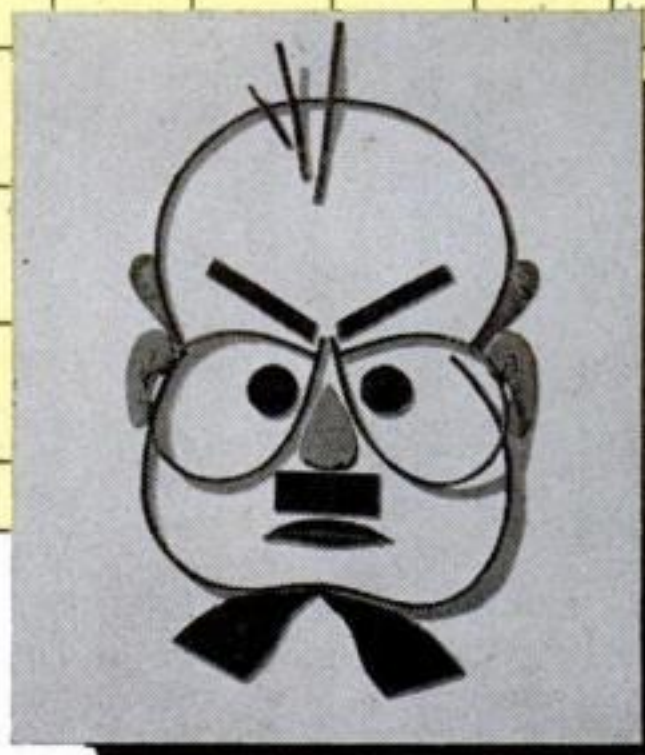
Peel the protective cloth off the adhesive film, which is on the weaker magnetic face, and the tape will stick to paper, leather, wood, paint, or plastic, thus giving these surfaces a magnetic grip. For heavier duty, rub the adhesive

CONTINUED

167



CUT FACIAL FEATURES from magnetic tape, pasting two widths to thin card for wide pieces. Slice off narrow strips for head outline and glasses. Thin ones will bend to contour; set wide strips on edge.

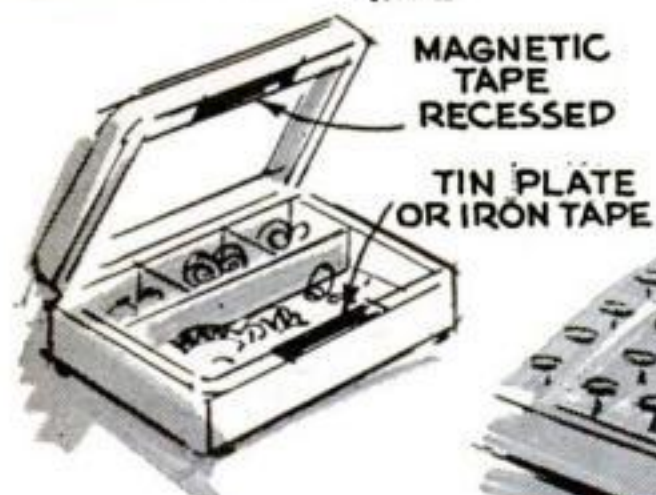
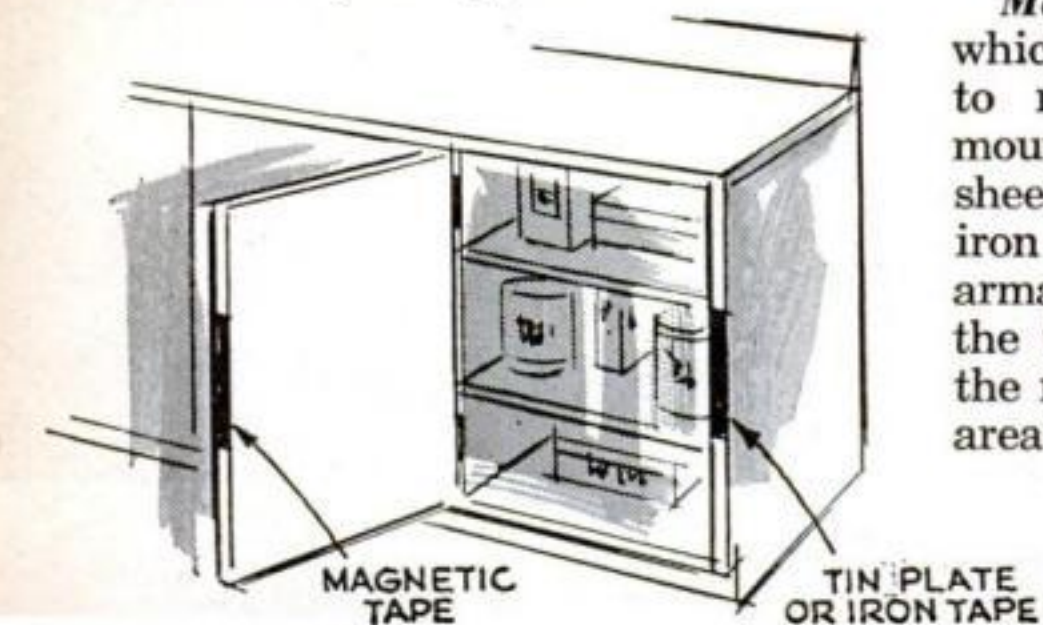


1 SQUARES

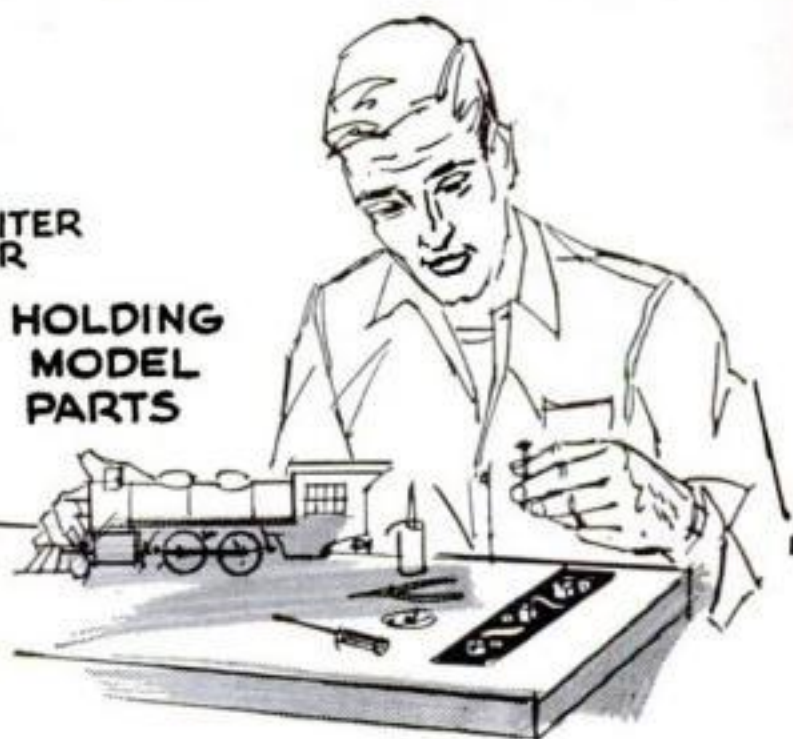
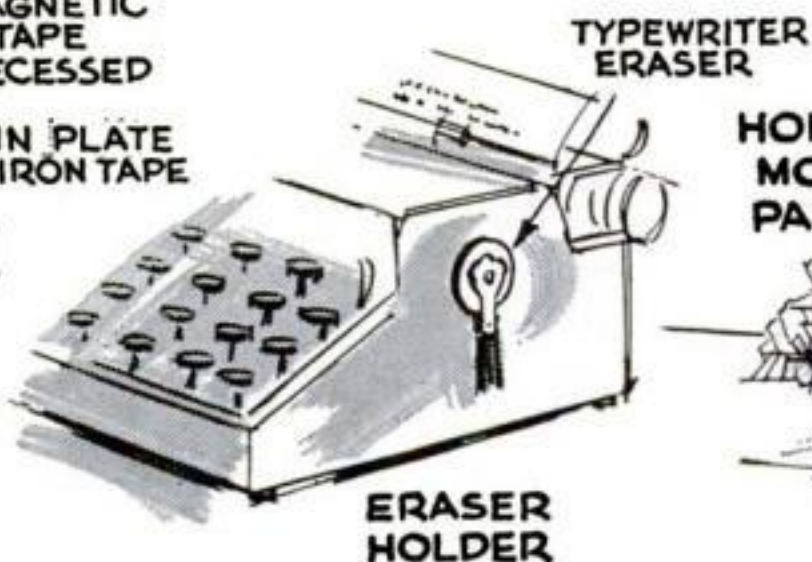
10 ways to use magnetic tape in the home, shop, and car

backing off with the fingers, roughen the tape with sandpaper, and stick it on with any modern cement.

Making it cling. To make objects to which the tape has been attached cling to non-iron surfaces, you need only mount a magnetic armature on these—sheet iron, tin plate, or a new plastic-and-iron foil with adhesive backing. This armature should be of the same area as the tape. Countersink the screws or set the nails holding it, to leave the contact area as flat as possible.



LATCHES AND CLOSURES



For stronger magnetic attraction in a given area, double the tape. Cement on a first layer, strong side out. Place a second one on top without cement, also strong side out, letting it slide into the position in which it clings tightly. Now mark or cut this piece to insure cementing it on in exactly this alignment. Use a thin coat of adhesive.

Magnetic catches. For doors, use single tape thicknesses as long as needed; a 3" piece will usually do. If a wooden door is warped, mount the catch on the corner that stands open, so holding the warp in. Neat closures for jewel and glove boxes can be made by recessing tape and armature and covering both thinly with paint.

Small tools and gauges can be kept on a doubled strip of tape fastened to the workshop wall or bench backboard. Because of the pole arrangement, there seems little tendency to magnetize tools so held. Narrow strips will stay in any shape you place them on iron or tin plate. Charts, graphs, and map lines laid out this way are clear and permanent, yet readily shifted. Signs and markers painted on tape will stick to ferrous objects, sheet iron, or wire screening.

For the car. Besides holding sun-glass cases and cigarettes on the dash, the tape can be laid in strategic spots to silence hood and door squeaks or seal rain leaks. It clings permanently, withstands heat and weather, conforms to curves. Don't bend it too sharply (it can break) or place it where sharp metal edges or corners can gouge it.

Stick a 2½" strip to one face of a fine-grained plastic sponge to hold it on the dash. Cut razor slits in the upper face

CONTINUED

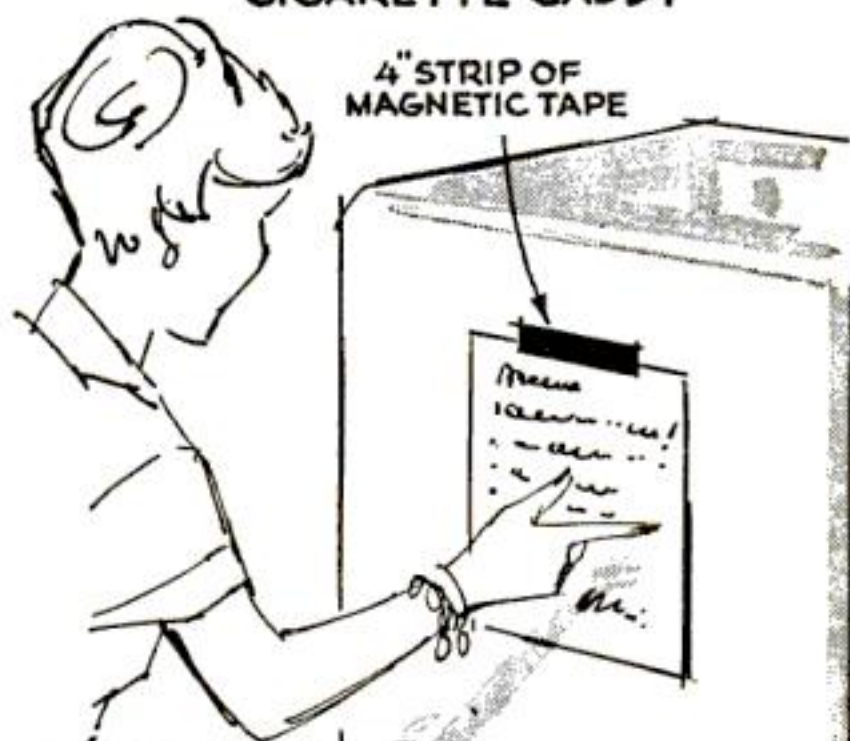


FOR HOLDING
DROP CLOTH



MAGNETIC TAPE
SLIPPED UNDER
WRAPPER

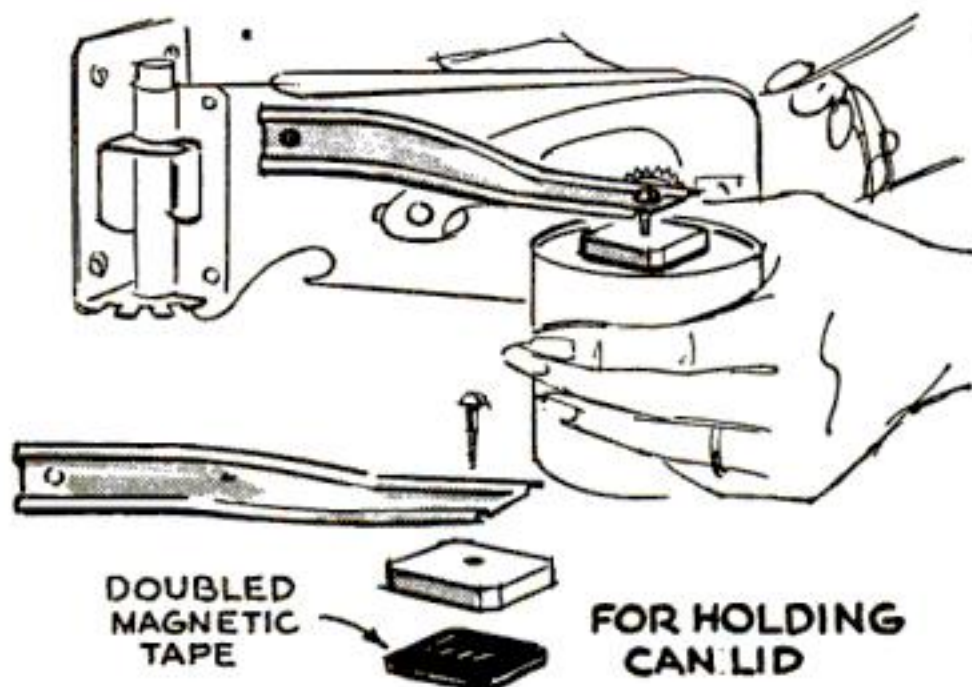
CIGARETTE CADDY



4" STRIP OF
MAGNETIC TAPE

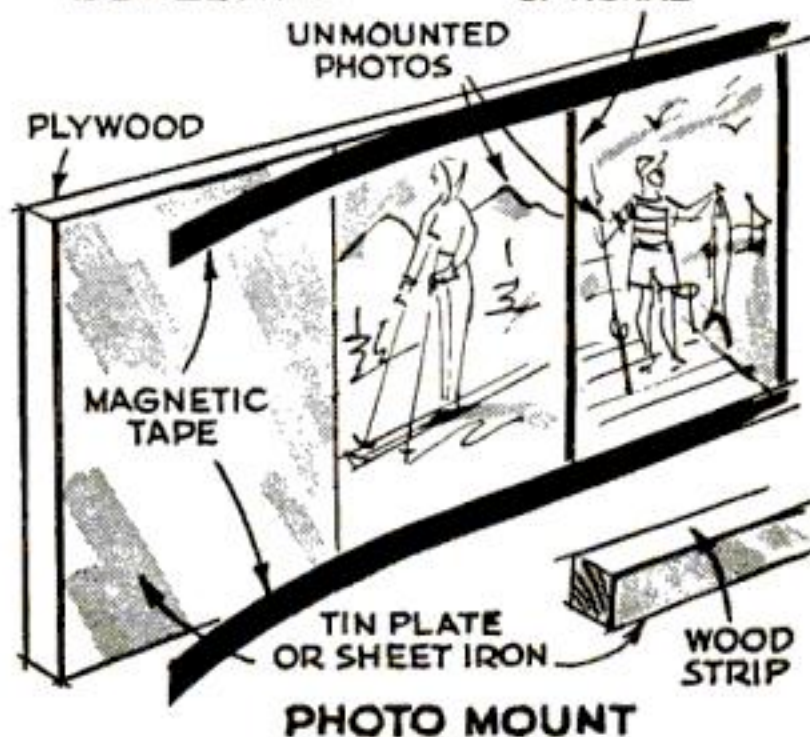
REFRIGERATOR
BULLETINS

TAPE DIVIDER
OPTIONAL



DOUBLED
MAGNETIC
TAPE

FOR HOLDING
CAN LID



PLYWOOD

MAGNETIC
TAPE

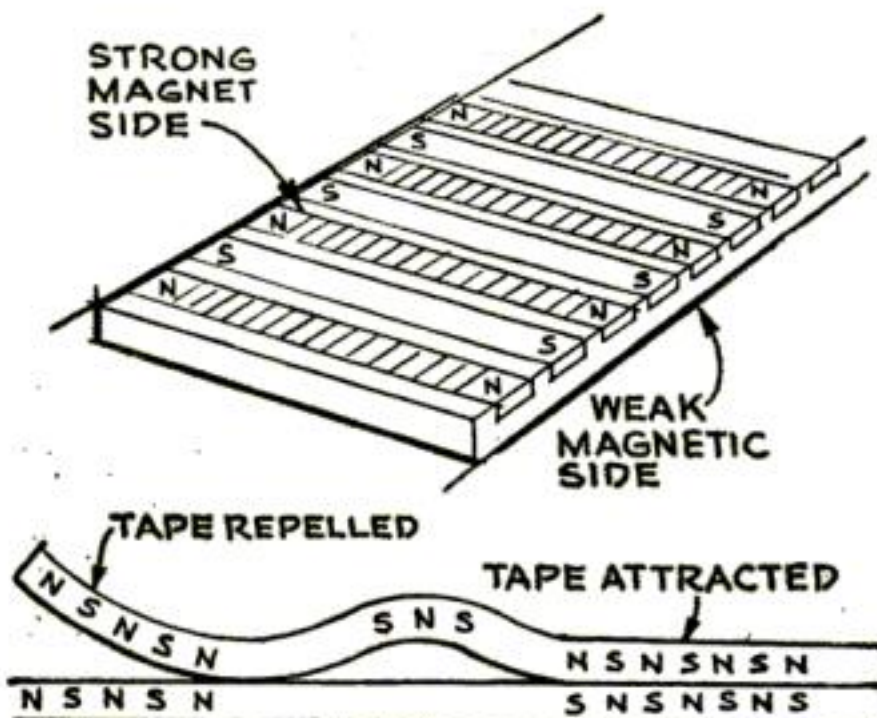
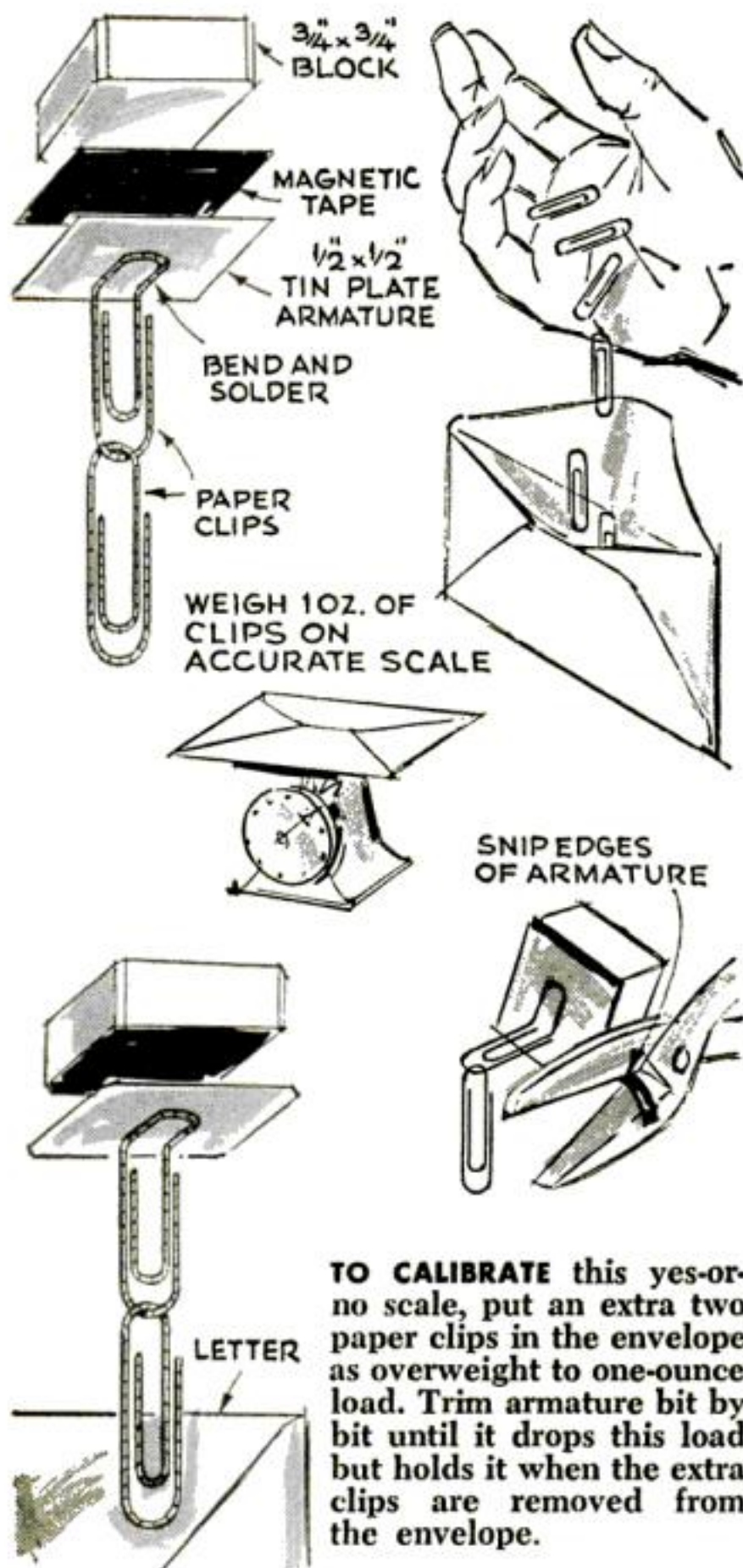
UNMOUNTED
PHOTOS

TIN PLATE
OR SHEET IRON

WOOD
STRIP

PHOTO MOUNT

Scale drops overweight letters



to hold coins for parking and tolls. A cloth with bits of tape along one edge will cling to the windshield frame, keep frost off the glass. The same simple dodge can be used to hold drop cloths against the fender or body when you're working on the car.

Around the house. You can seal refrigerator-door leaks that hasten frosting. Find them by trying to pull out paper strips with the door closed. Place tape against the metal jamb to seal the gap. Drafts in steel casement windows can be stopped the same way.

Older wall can openers can be fitted with magnetic lid holders. Unframed photos mounted for display with strips of tape (which can be painted) are easily changed.

Games are a challenge. Cement tape to the bottom of checkers and chessmen and they'll stay put on a tin-plate board. Scrap bits of tape will do. Cut out animal or people figures for children to maneuver on a painted iron board, or cut features for a gallery of funny faces.

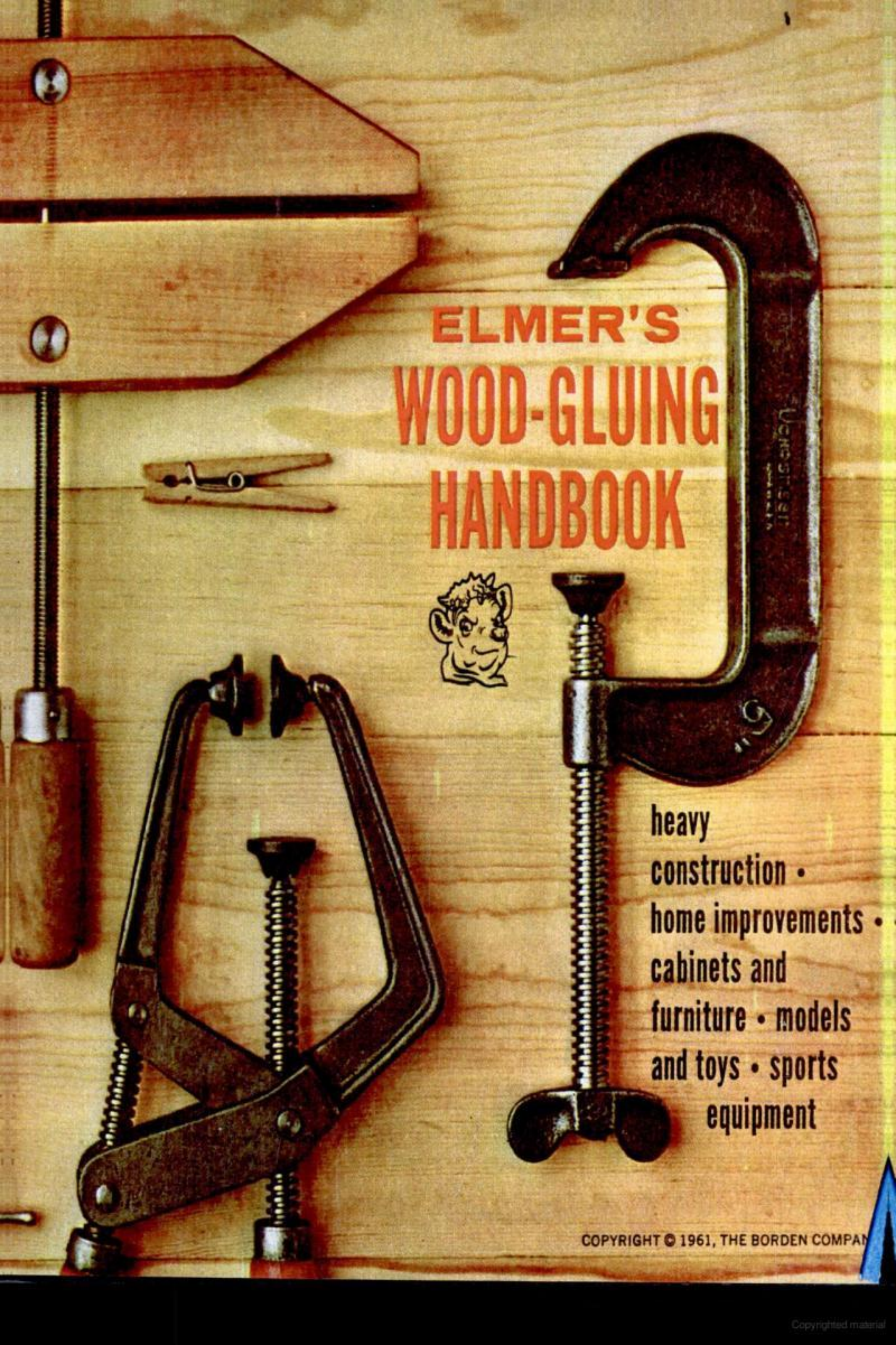
A good toss game consists of a sheet-iron board ruled into squares—three or four to a side—and round magnetic disks. Cement tape to one side of milk-bottle tops or unbreakable poker chips. Tossed flat with a slight spin, they'll stick to the board.

For tic-tac-toe, each player throws until he lands on an unoccupied square. Disks that fall off, or land across a line or on an occupied square, don't count. First to get three in a row wins.

With rocket ships painted on the disks, you have a modern version of the old battleship game. A player owns any square he lands on, until his opponent hits the same square. The first ship is then "destroyed" and out of the game. The winner is the one who commands most squares when all disks have been played.

Invented in West Germany and made here by a major rubber company, Magnyl Tape is distributed by Applied Magnetics Corp., Leeds, Mass.

TAPE IS MAGNETIZED crosswise, poles forming alternating bars as shown. If one piece is drawn along atop another with the strong faces together, upper strip flips up as like poles are aligned, flattens itself as unlike ones line up, producing an odd flip-flop bounce.



ELMER'S WOOD-GLUING HANDBOOK



heavy
construction •
home improvements •
cabinets and
furniture • models
and toys • sports
equipment

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Woodworker's gluing chart

TYPE OF MATERIAL	GLUE FOR MAXIMUM STRENGTH WATERPROOF JOINT: (BOATS, EX- TERIOR CONSTRUCTION, ETC.)	GLUE FOR LOW-COST WATER- RESISTANT JOINT (IN ORDER OF PREFERENCE)
All general gluing of hard and softwoods	Elmer's Waterproof Glue	Elmer's Plastic Resin Glue Elmer's Casein Glue Elmer's Glue-All
Particle and chip boards to wood	Elmer's Waterproof Glue	Elmer's Plastic Resin Glue Elmer's Casein Glue Elmer's Contact Cements Elmer's Glue-All
Plywood to decorative plastic laminates	Elmer's Waterproof Glue	Elmer's Casein Glue Elmer's Contact Cements Elmer's Plastic Resin Glue
Laminating heavy framing members	Elmer's Waterproof Glue	Elmer's Casein Glue
Veneering, inlays, cabinetwork	Elmer's Plastic Resin Glue	Elmer's Plastic Resin Glue (extended) Elmer's Glue-All (small jobs)
Bonding oily woods (teak, pitch pine, osage, yew, etc.)	Elmer's Waterproof Glue	Elmer's Casein Glue—sponge surface with dilute caustic soda one hour before gluing
End-wood joints, mitered joints, scarf joints	Elmer's Waterproof Glue	Elmer's Glue-All Elmer's Plastic Resin Glue (heavy mix)
Loose-fitting joints, relatively rough surfaces	Elmer's Waterproof Glue	Elmer's Glue-All Elmer's Casein Glue (heavy mix)
Doweling	Elmer's Waterproof Glue	Elmer's Plastic Resin Glue Elmer's Glue-All
Hardboard to ply- wood, wood or itself	Elmer's Waterproof Glue	Elmer's Plastic Resin Glue Elmer's Casein Glue Elmer's Glue-All Elmer's Contact Cements
Gluing porous mate- rials—linoleum, can- vas, etc. to wood	Elmer's Waterproof Glue	Elmer's Plastic Resin Glue Elmer's Casein Glue Elmer's Contact Cements
Gluing plastics, metal foil, etc. to wood	Elmer's Contact Cements	Elmer's Casein Glue (sand both surfaces)
Gluing hardware, boat fittings and other metal parts to wood	Elmer's Epoxy Glue	Elmer's Epoxy Glue

There's an ELMER'S Glue for every job you do.

What you should know about ELMER'S Glues



ELMER'S Glues and Cements are the finest adhesives you can buy. Each has been formulated to meet specific gluing needs. Choose the right ones and all of your wood-working projects will be as strong as modern chemistry can make them.

ELMER'S GLUE-ALL. A pure white polyvinyl acetate emulsion glue that dries fast, forming a transparent bond. Use it wherever waterproof joints aren't essential—for light house-interior construction and renovating work, furniture assembly and repair, toy and model making, and for joining such materials as cloth and leather to wood.

ELMER'S PLASTIC RESIN GLUE. A powdered urea resin product that you mix with water. It has a high degree of water resistance. Use it, as the pros do, for high-grade furniture construction. Apply it to clean, close-fitting surfaces. Cure, under pressure, for at least 10 hours at 70° F.

ELMER'S WATERPROOF GLUE. A two-component adhesive of liquid resorcin resin and powdered catalyst. Blended, they produce the strongest waterproof wood joints pos-

sible. Apply at 70° F. or over, and let cure for at least 10 hours under pressure.

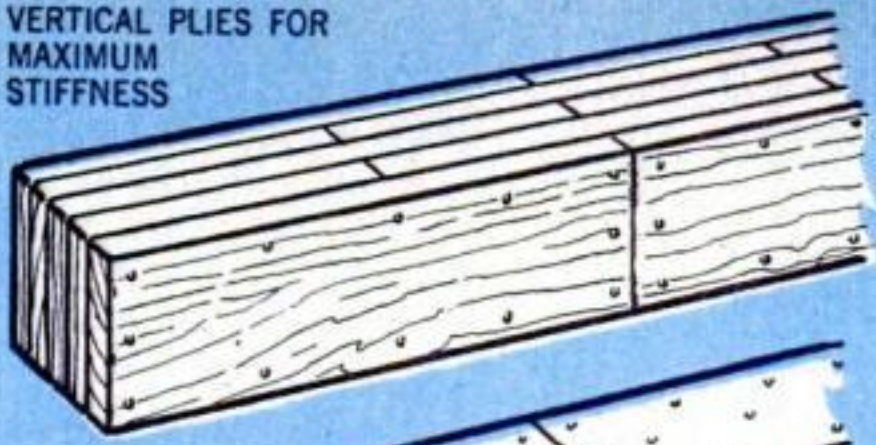
ELMER'S CASEIN GLUE. A powdered casein product that mixes smoothly with water. It sets at much lower temperatures than other glues, and faster at normal room heat (only 3 hours at 70°). Because it's inexpensive, and has better-than-average filling qualities, it's fine for heavy wood gluing.

ELMER'S CONTACT CEMENT. Borden offers two types—*regular* and *non-flammable*. Completely non-staining. Ideal for applying wall paneling, and for covering counters, cabinets and table tops with both porous and non-porous surfacing materials ranging from linoleum and leather to plastic laminates.

ELMER'S EPOXY GLUE. The new wonder adhesive that's so strong it takes the place of riveting in many airplane assemblies. ELMER'S Epoxy Cement is a two-component team of adhesive and hardener. Squeeze out equal parts and blend with a knife. Use the mix for heretofore impossible jobs—among them, attaching wood to metal without unsightly fasteners.

Heavy construction

VERTICAL PLIES FOR
MAXIMUM
STIFFNESS



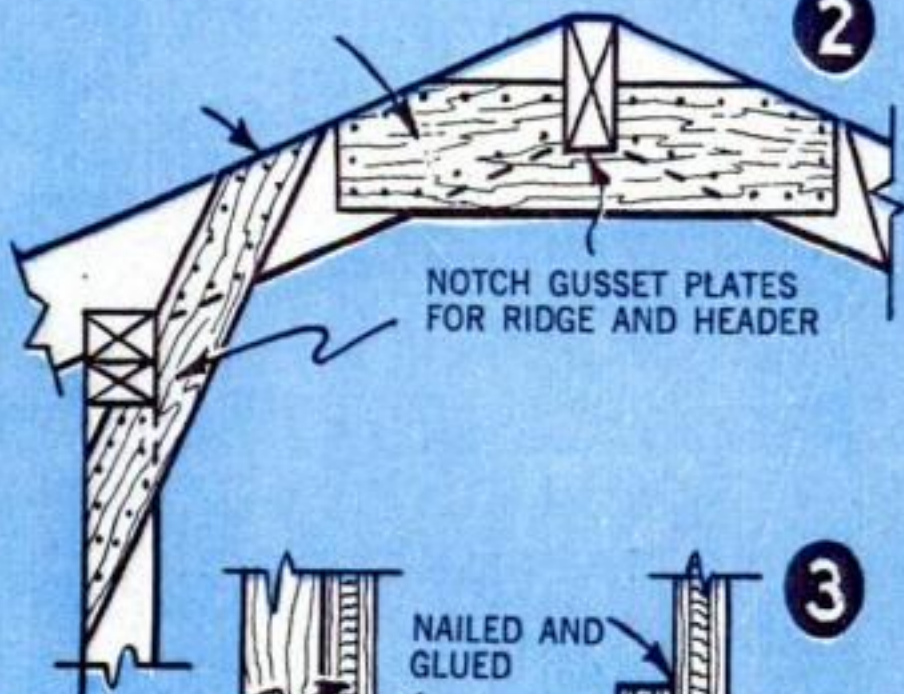
HORIZONTAL PLIES FOR
MAXIMUM STRENGTH



1

2

NOTCH GUSSET PLATES
FOR RIDGE AND HEADER



3

NAILED AND
GLUED

1/4" PLY-
WOOD

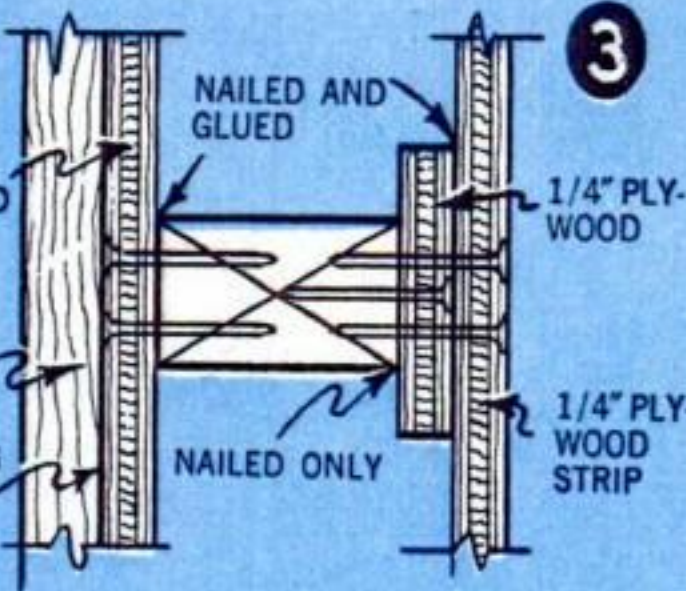
5/16" PLYWOOD
SHEATHING

SIDING OR
SHINGLES

BUILDING
PAPER

NAILED ONLY

1/4" PLY-
WOOD
STRIP



4

3/4" (DRESSED) LUMBER

3-PLY PANEL

3/4" (DRESSED)
LUMBER



INDUSTRY has developed exciting new construction techniques using wood, plywood and hardboard in conjunction with today's superior glues. You can apply the same methods when you build that new carport, patio, house trailer or dreamboat. Remember that nailed-and-glued joints are twice as strong as joints depending on nails or screws alone. Like a unitized car body, a glued structure eliminates slippage at joints, and possible loosening or shearing of mechanical fasteners. ELMER'S Casein, Plastic Resin and Waterproof Glues are your best possible bets for heavy construction. Make your choice from the chart on page 2.

SUPER-STRENGTH BEAMS. You may need these for columns, headers, and door and window lintels. Those formed of boards nailed and glued together are stronger and less likely to check than single timbers of equal size. Drawing 1 shows two ways of assembling the plies. When two or more boards are used for each ply, stagger the end joints. If you're working with horizontal plies, the board ends should be cut to mating diagonals, or "scarfs." With both methods of assembly, drive nails before the glue sets—one for each 5 square inches of joint area, plus additional nails at board ends.

FRAMING. Reinforcing plates, or "gussets," applied to stress areas in framing "beef up" construction greatly. Cut the gussets from 3/8-inch or thicker plywood, and bond them to other structural members with nails and glue. Typical installations—where rafters meet at a roof ridge, and are fastened to a wall header—are shown in drawing 2.

POPULAR SCIENCE MARCH 1961

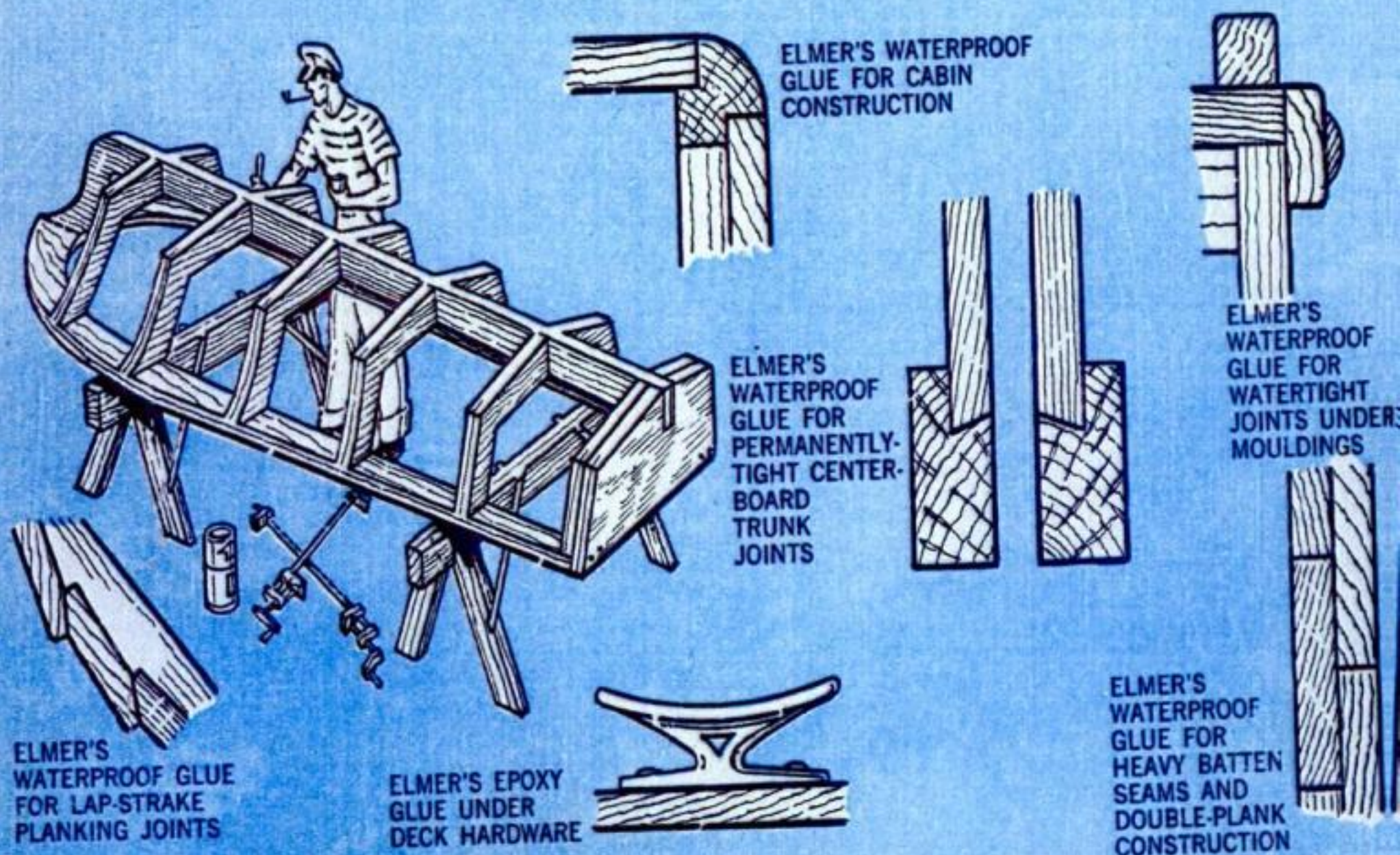
with ELMER'S glues

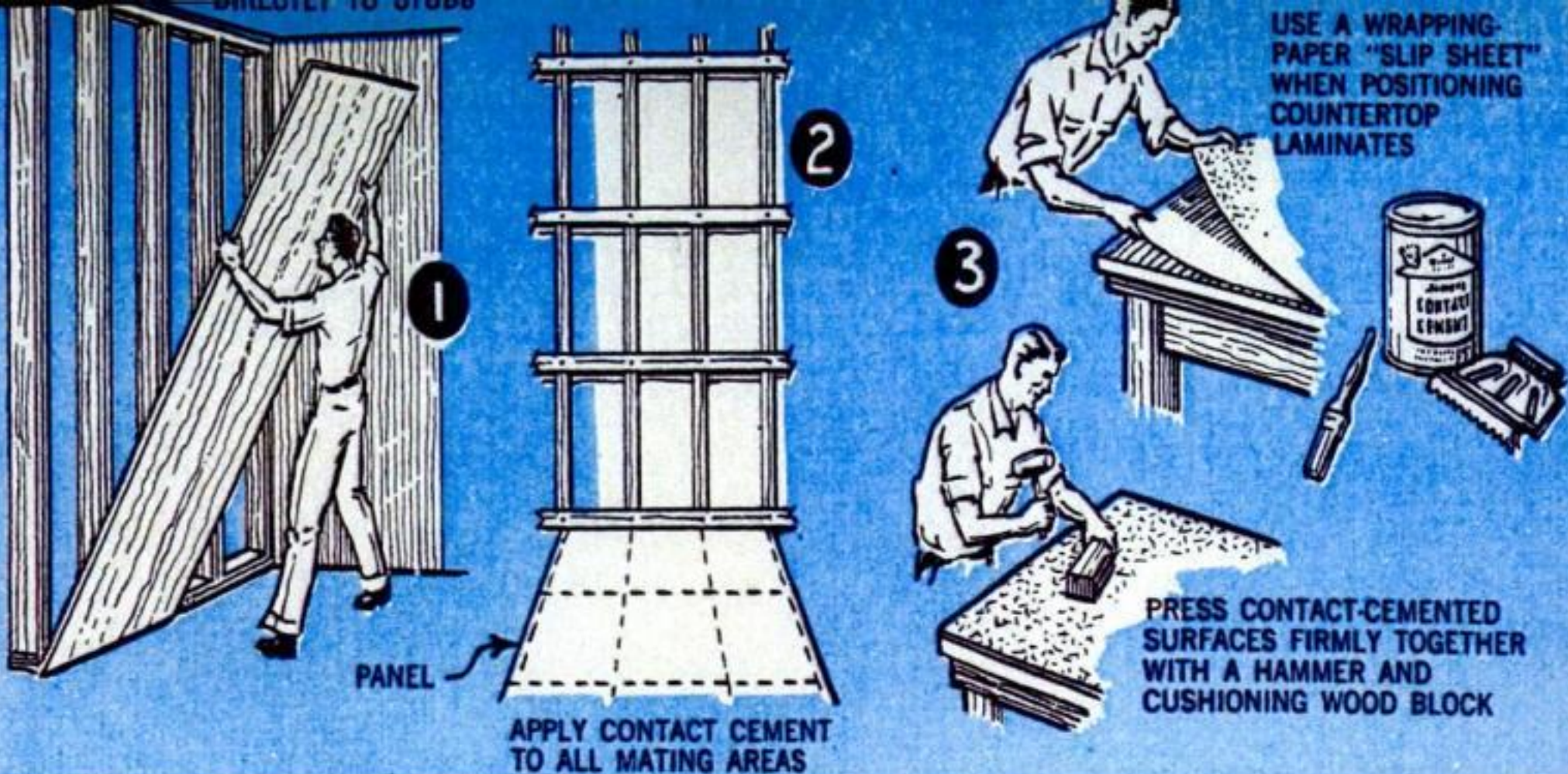
EXTERIOR WALLS. Plywood sheathing, glued as well as nailed to framing, is twice as rigid as the same material applied with nails alone, and three times as rigid as nailed diagonal sheathing. This reduces the chance of joint cracks in finish woodwork, and of door and window frames working out of square and causing binding. On the interior side of framing, do not attach wall panels directly with contact cement or glue. Instead, cut 2½-inch strips of ¼-inch plywood and use them as furring—nailing but not gluing them to the framing members. Then cement or glue the panels to the furring. This way, the unglued strips provide flexibility for slight movements caused by shrinkage of the framing (drawing 3).

HEAVY DOORS. Sturdy but attractive doors for a tool shed, shop, cabana or wall-en-

closed garden are easily made this way: Cut a fir plywood panel the size of the proposed door. Apply ELMER'S Casein Glue to one side and screw random-width, ¾-inch dressed wood paneling boards to that surface. Then repeat the process on the other side. For distinctive shadow lines, use tongue-and-groove stock with bevel edges (drawing 4).

BOAT CONSTRUCTION. Whether you're assembling a boat kit, building your own craft from scratch, or simply making routine repairs, use ELMER'S Waterproof Glue for all rigid, wood-to-wood bonds. That goes for everything from ship planking to building up laminated ribs and keels. ELMER'S Epoxy Glue is a first choice, too, for bedding metal fittings against wood parts before applying screws.





Home interior improvements with

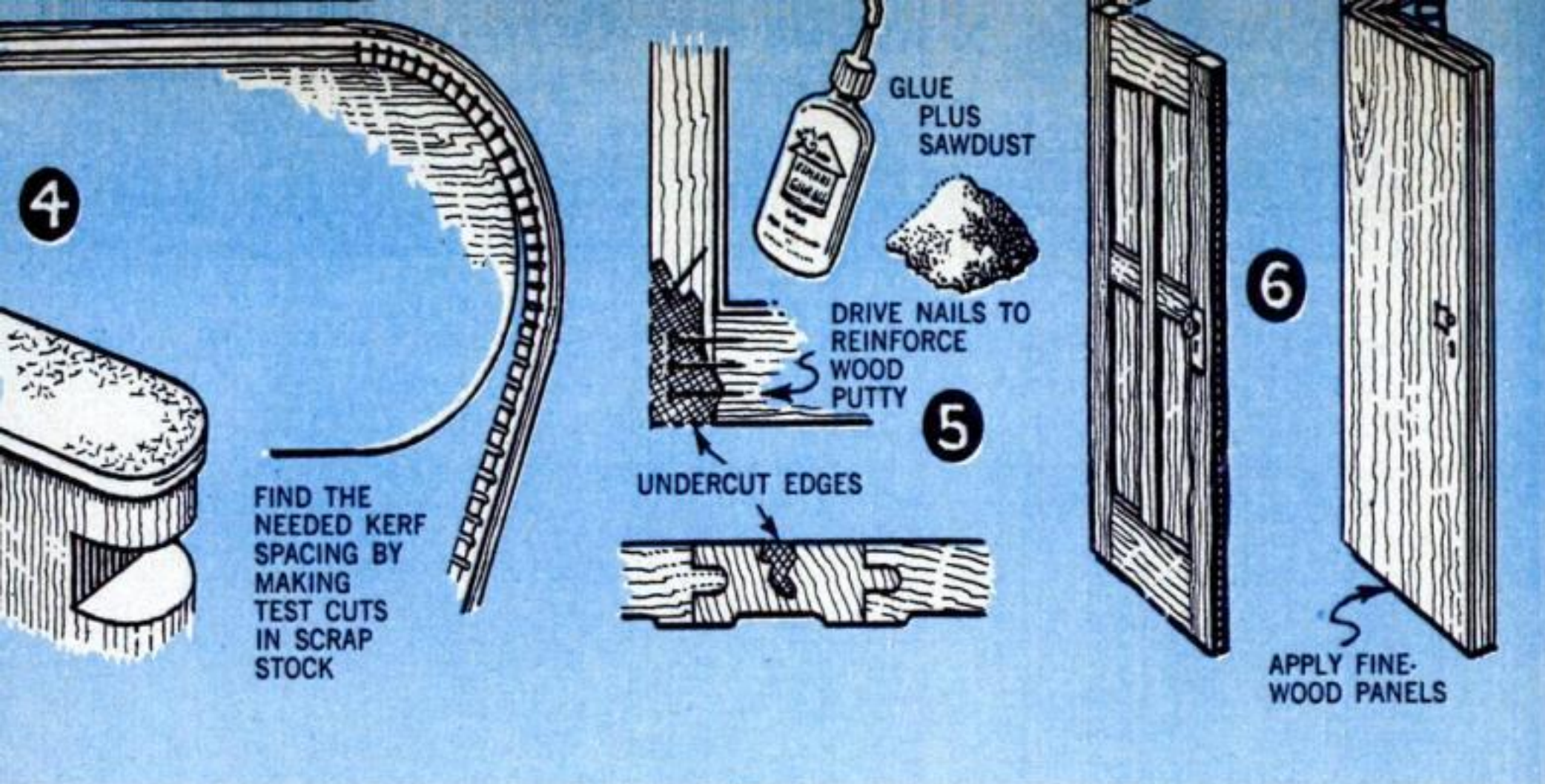
FINISHING off a basement rumpus room or attic den? Remodeling a kitchen or bath? Adding built-ins or a bow-bay window? ELMER'S Glues and Cements are as necessary for such projects as the proverbial hammer, saw and screwdriver. Here's just a sampling of their hundreds of applications in new construction and renovating work:

APPLYING WALL PANELING. Sculptured and fine wood-veneered plywood, distinctive chip and particle boards, handsomely-finished hardboard—these and many less exotic paneling materials are neatly and easily applied to framing with either ELMER'S Plastic Resin Glue or Contact Cements. Use Plastic Resin Glue, if you like, to attach wallboard directly to studs. Supplement it with nailing to provide necessary pressure while the adhesive sets. Choose either regular or non-flammable Contact Cement for sightly, nail-free bonding. With new framing, cut and pre-fit the panels, marking their areas of contact with the studs. Apply two

coats of Contact Cement to each mating surface, allowing sufficient drying time between coats and before positioning (drawing 1). Force the adhesive-coated areas firmly together with light blows of a wood-block cushioned hammer. If you bond panels to unpainted plaster or plywood sheathing, mark the backs vertically and horizontally at 16-inch and 24-inch intervals, respectively. Draw corresponding lines on underlay material and apply 3-inch wide bands of cement to all markings. When surfaces are uneven, use furring strips (drawing 2).

PLASTIC LAMINATES. These table and counter-top materials are conveniently applied with ELMER'S Contact Cements. If underlying surfaces have been finished previously, remove the old coating and sand down any irregularities. Clamp the laminate to the surface and cut slightly oversize with a portable sabre-saw or fine-toothed hand-saw. Apply a uniformly thick coat of cement to both bonding surfaces and let dry

POPULAR SCIENCE



ELMER'S glues

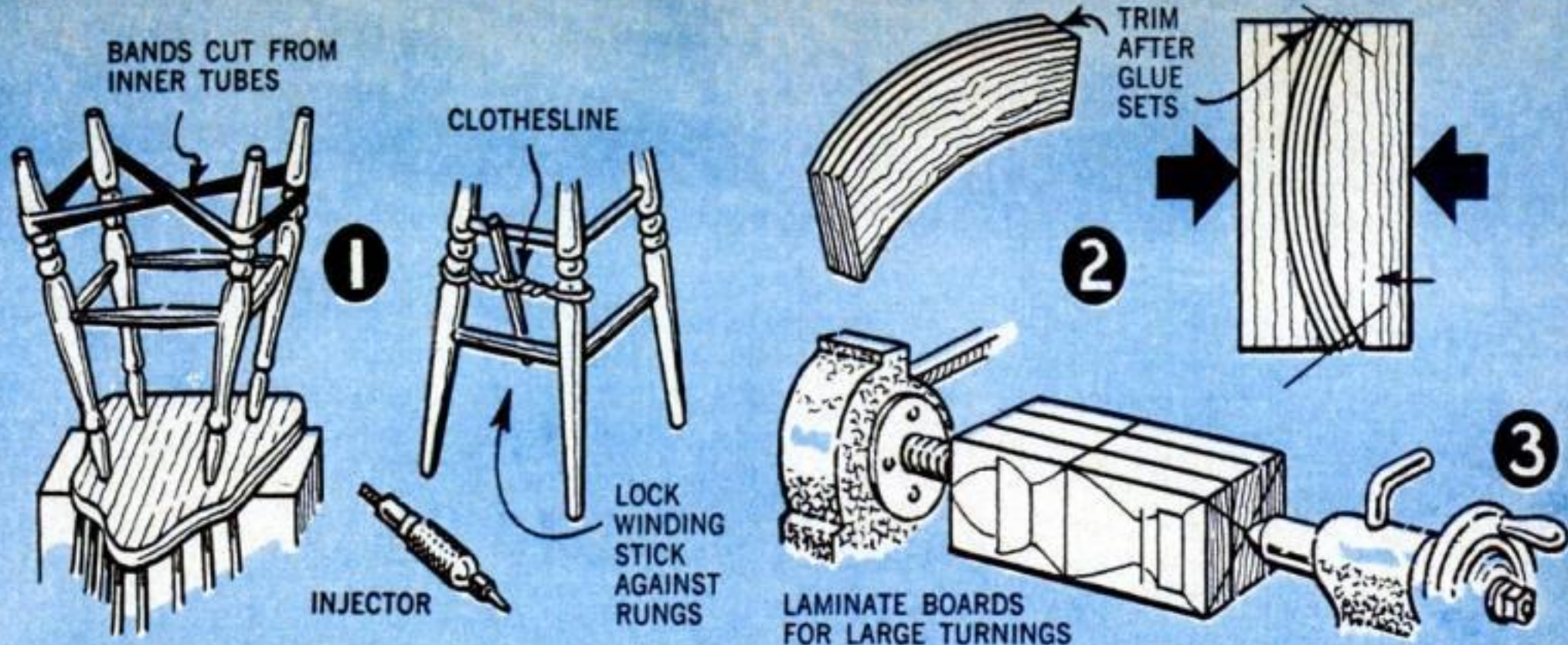
thoroughly (preferably apply second coat to wood). Next, cover the underlying surface with wrapping paper and position the laminate over it. Withdraw the paper slowly, pressing the laminate down behind it. Working from the center outward, use a hand roller, rubber mallet or hammer and wood block to apply further pressure to the entire surface. Finally, file the edges of the laminate flush and attach metal, wood or plastic trim to the edges (drawing 3).

BUILT-INS. Use suitable wood joints of the types shown on page 9, when framing room dividers, cabinets, shelving and storage walls. ELMER'S Glue-All and Plastic Resin Glue are both fine adhesives for assembly. Apply clamp pressure wherever possible; in other cases, finishing nails will hold parts snugly together while they set. Countersink the nail heads, and fill the holes with a practically undetectable wood putty made by mixing glue with sawdust of the same material as the product. Occasionally, you

may want to bend wood or plywood over a curved frame. Run close-spaced parallel grooves, or "kerfs," across the back of the stock with a bench saw. These increase the wood's flexibility to that of the thinned-down areas (drawing 4).

PATCHING DAMAGED WOOD. Commercial wood putty is fine for filling cracks in and between floor boards, and damaged doors, window frames and baseboards. But for the fussy jobs where a close, natural-wood color match is necessary, mix sawdust with ELMER'S Glue-All or, in spots exposed to moisture, Waterproof Glue. Before troweling in the putty, remove all infirm wood around the cavity, and undercut the sides. If the patch will be subjected to much strain drive nails, as shown in drawing 5, to reinforce the putty.

NEW DOORS FROM OLD. A battered panel door becomes a modern flush door when you remove its finish and bond 1/4-inch plywood to both sides with ELMER'S Glue-All (as shown in drawing 6).



Cabinet and furniture work with

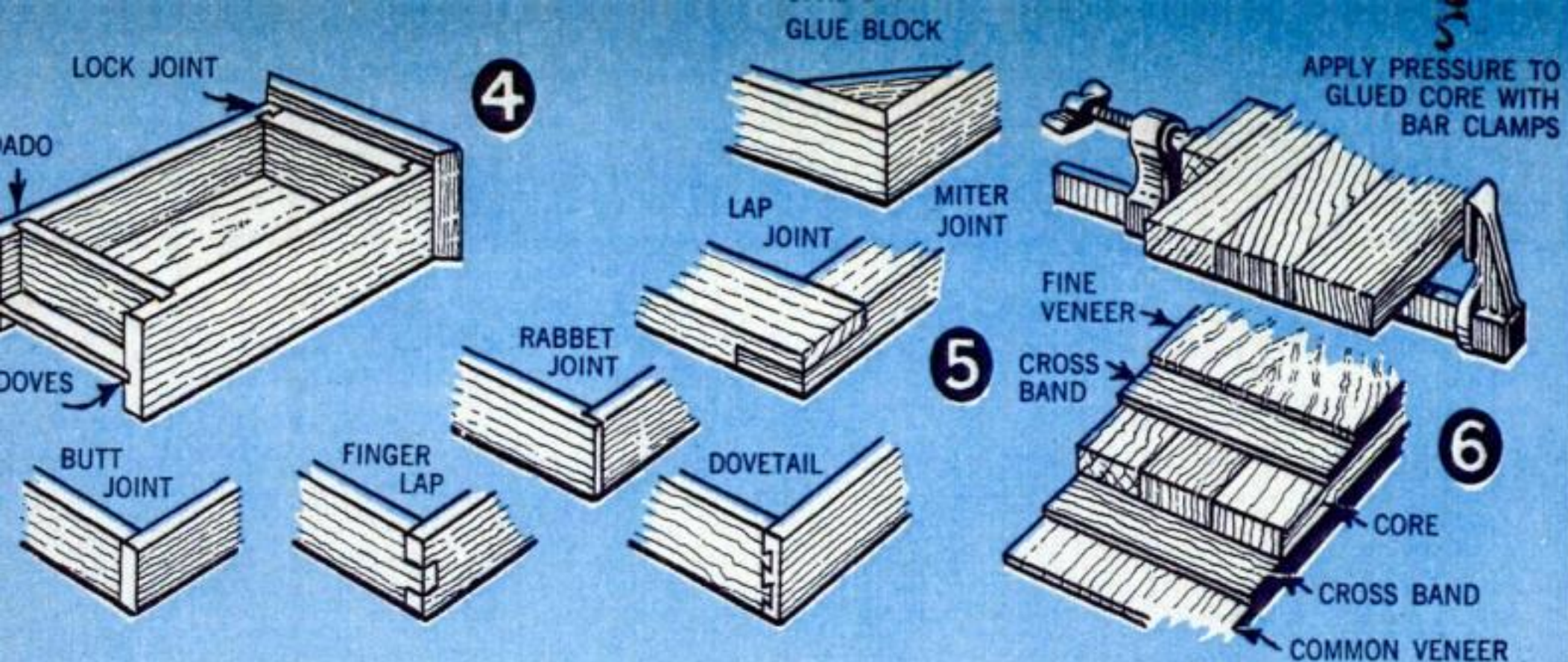
THE HALLMARK of fine furniture and cabinet work is good gluing. This depends on the quality of the adhesive, the care taken in applying it, and proper clamping. ELMER'S Glue-All and Plastic Resin Glue make the best furniture bonds. Providing the right gluing conditions is easy. While no craftsman has ever complained of owning too many clamps, you can get by with relatively few, plus a bit of ingenuity.

TABLES AND CHAIRS. Here, adequately-deep sockets and mortises, along with snug fit, are essential for lasting glue joints. With new work, apply a slight taper to the shouldered-down ends of spindles and to tenons for firm wedging action. When regluing, don't just slap on the new adhesive. First, scrape off all former, hardened glue to expose the wood pores for proper penetration. The single exception is the rickety chair or table whose members haven't yet parted company. There, your best bet is an inex-

pensive tool called a glue injector. To use it, you bore a $\frac{1}{16}$ -inch hole through the wood and into each loosened joint. Then you insert the tip of the injector and squeeze in glue with a plunger. Commercially-made bar clamps are useful for putting pressure on chair and table assemblies. But you can do it simply by lacing strips of old inner tubes between parts, or using tourniquet action of a stick on clothesline (drawing 1).

LAMINATING. For maximum strength, curved parts like rockers and the tops of chair backs must be formed by bending the wood. With solid stock, this involves prolonged steaming, followed by a day's drying time in heavy forming equipment. The fast and easy alternative is to build up the part from a number of thin plies, gluing them face-to-face and placing the assembly between comparatively light-forming blocks immediately after completion (drawing 2). Laminating is useful, too, when reproduc-

POPULAR SCIENCE



ELMER'S glues

tions of period furniture call for heavy wood turnings. Thoroughly seasoned stock of the required thickness is hard to find, and expensive. Instead, glue a number of thinner plies together (drawing 3).

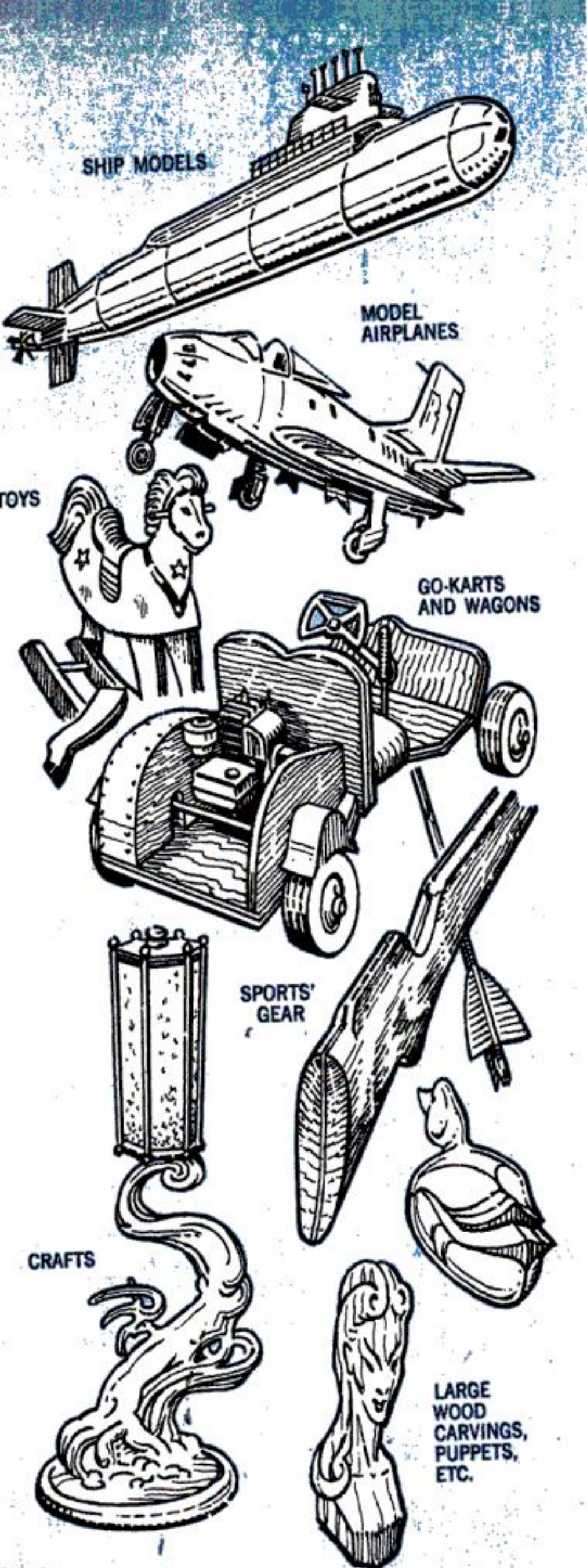
CABINETS AND CHESTS. Smooth-sliding drawers and well-fitting doors depend on rigid frames and enclosures. When you combine ELMER'S Glue-All or Plastic Resin Glue with trim cabinetmakers' joints, you have an unbeatable team. If you're using miter joints at corners, back them up with reinforcing wood triangles, or "glue blocks." Drawers, too, benefit by gluing. Today's popular "concealed-edge" type can be made without complicated table-saw set-ups, just by gluing face panels with beveled vertical edges to the forward structural members of the assemblies. Drawing 4 shows such a drawer and, with drawing 5, illustrates wood joints commonly used in furniture construction.

MARCH 1961

HI-FI CABINETS. These, and most particularly speaker enclosures, must not produce vibration or resonance. Heavy plywood members bonded with ELMER'S Glues insure distortion-free sound.

BOOKCASES. Hardboard or plywood panels nailed and glued to the backs of frame bookcases "beef up" construction; make possible non-sagging shelves with spans as long as 8 feet between supporting partitions.

VENEERING. Experts agree that the most beautiful wood-surface textures are produced by sawing heavy tropical trees in ways that expose highly-figured grain patterns. Veneers of this type are comparatively inexpensive. Apply them to plywood underlays with ELMER'S Plastic Resin Glue, and hide the laminated edges with veneer strips. For heavy jobs, glue a number of softwood boards or planks edge to edge. Then apply a thin wood panel to each surface of this core, with its grain at right angles to that of the boards. Cover one of these "cross-bands" with finewood face veneer, the other with a plainer veneer (drawing 6).



Toys and models

STRONG, clean-to-handle and clear-drying ELMER'S Glue-All has no equal as a fun-project adhesive. Use it to assemble and repair practically any indoor toy or model made of wood. The exceptions, of course, are those intended for bathtub launching. There, and for outdoor service, ELMER'S Waterproof Glue is tops. A check list of the more obvious uses for these two adhesives includes:

Toy and model airplanes and rockets, boats, old-time automobiles, racing cars, historic wagons and coaches, locomotives and rolling stock. Right-of-way structures and scenery for table-top railroads. Bodies for soapbox derby racers, go-karts, quarter-racers. Dollhouses, playhouses, miniature furniture. Marionettes, puppets.

When gluing small softwood parts together, clamping is rarely necessary. If it is (for alignment rather than strength), use rubber bands or spring-type clothespins. Build up laminated blocks for ship-model hulls, marionettes, hobbyhorses and the like, just as you would for furniture parts. Lastly, don't overlook ELMER'S Epoxy Glue when you're attaching wooden wheels to wire axles, anchoring car bodies to chassis, or applying brass, aluminum or pot-metal boat fittings to a hull or superstructure.

Sports' equipment

CUSTOM-shaping your own laminated gunstocks, decoys, fish lures, aquaplane, surfboard or water skis? For these and dozens

POPULAR SCIENCE

of other sports' equipment projects, ELMER's Waterproof Glue is the only adhesive for craftsmen who want the best. Joints made of it withstand practically everything: Continuous outdoor exposure, zero-cold or boiling water, moist or dry heat, mould or fungus, solvents, alkalis, acids.

Arts and crafts

WOOD sculpture, stock for hardwood bowl turning, and blanks for pattern making often

call for laminated assemblies. Use ELMER'S adhesives. Glue-All is the perfect, colorless bonding agent for driftwood lamp assemblies. Bed the electrical fixtures in place with ELMER'S Epoxy Glue. Metal and wood are being combined today in popular wire-sculpture projects ranging from book ends and candle holders to aquarium frames, mobiles and lamp shades. Again, ELMER'S Epoxy Glue is the right adhesive. Planter boxes? Use exterior-type plywood and ELMER'S Waterproof Glue.

It all adds up to this: *There's an ELMER'S Glue for every job you do.*

Where to write for lists of woodworking plans:

Albert Constantine & Son, Inc.
New York 61, N. Y.
(catalog, 25¢)

California Redwood Assn.
Financial Center Bldg.
San Francisco, Calif.

Craftsman Wood Service Co.
2729 S. Mary St.
Chicago 8, Ill.
(catalog, 25¢)

Craig Craft
Tonawanda 1, N. Y.
(boat-plan catalog, 25¢)

Delta Mfg. Co.
600 E. Vienna St.
Milwaukee, Wis.

Dept. of Housing and Design
Cornell University
Ithaca, N. Y.

Douglas Fir Plywood Assn.
Tacoma 2, Wash.

Easi-Bild Pattern Co. Inc.
Pleasantville, N. Y.

Home Service Bureau
Masonite Corp.
111 W. Washington St.
Chicago 2, Ill.

Minnesota Woodworkers Supply Co.
1713 Olson Highway
Minneapolis, Minn.
(catalog, 10¢)

National Home Study Council
2601 16th St.
Washington, D. C.

U. S. Gypsum Co.
300 W. Adams St.
Chicago 6, Ill.

U. S. Plywood Assn.
55 W. 44th Street
New York 36, New York

Western Pine Assn.
Yeon Bldg.
Portland 4, Ore.



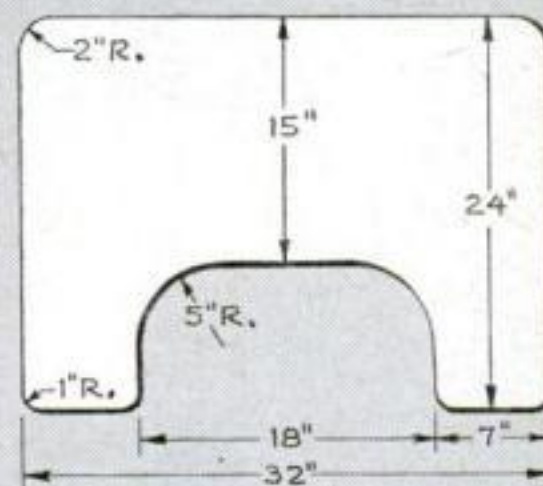
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Short Cuts and Tips

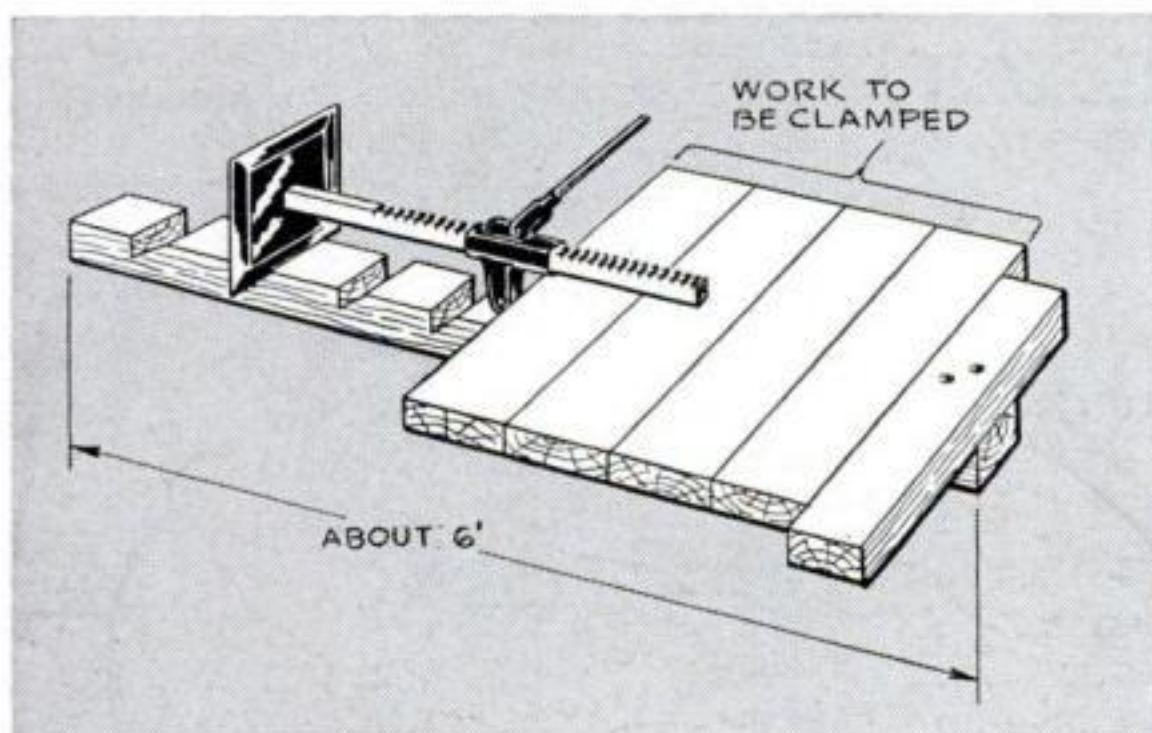
FROM PS READERS



Lap Board for Armchair

YOUR favorite easy chair becomes a writing desk, snack bar, or solitaire table when you bridge the arms with this easily made lap board. Once you're

through with the board you just lift it off and store it beside or behind the chair. The size shown fits standard chairs. Cut it from plywood, hardboard, or any other rigid sheet material, and smooth all edges.
—E. T. Roetman, Atlanta, Ga.



Using a Car Jack as a Bar Clamp

GOT a panel to glue up that's too wide for any of your clamps? You can rig up a device with unlimited capacity, using only an auto jack and two pieces of two-by-four. Half of the long piece should be notched every 6" to provide toe holds for the jack base. The short piece is fastened at the other end as a stop.—Steve R. Scadding, Toronto, Ont.

WHAT'S YOUR MECHANICAL IQ?

How Was This Thread Cut?

YOU can drive your shop-wise friends crazy trying to figure how you made this bolt with a varying pitch thread.

Near the hump (see photo) it starts out as a watch-screw thread—about 100 threads per inch—then widens progressively until it becomes a fat 15 or 20 threads per inch near the bolt head.

The trick is simple, but seldom guessed. Turn the page for details on cutting this completely impractical thread.



Short Cuts and Tips

FROM PS READERS



Trimming a Washer to Size

CAN'T locate a washer the size you need to repair a dripping faucet? You can trim an oversize washer to the exact diameter by turning it onto a wood screw that's slightly larger than the hole, and chucking this in an electric drill. Spinning the edge of the washer against sandpaper or a file will turn it down.—*Harry Wheeler, Toledo, Ohio.*



Tumble-Drum Cleans Chains

AN ARMY man's ingenuity solved the problem of cleaning dirty or rusty truck chains. Sgt. C. L. Murphy attaches a 50-gallon drum to the wheel of a 2½-ton truck and fills it with old chains and newspaper. Then he jacks up the back wheel, starts the motor, and tumbles the chains until they're as shiny as new.—*William R. Kreh, Silver Spring, Md.*

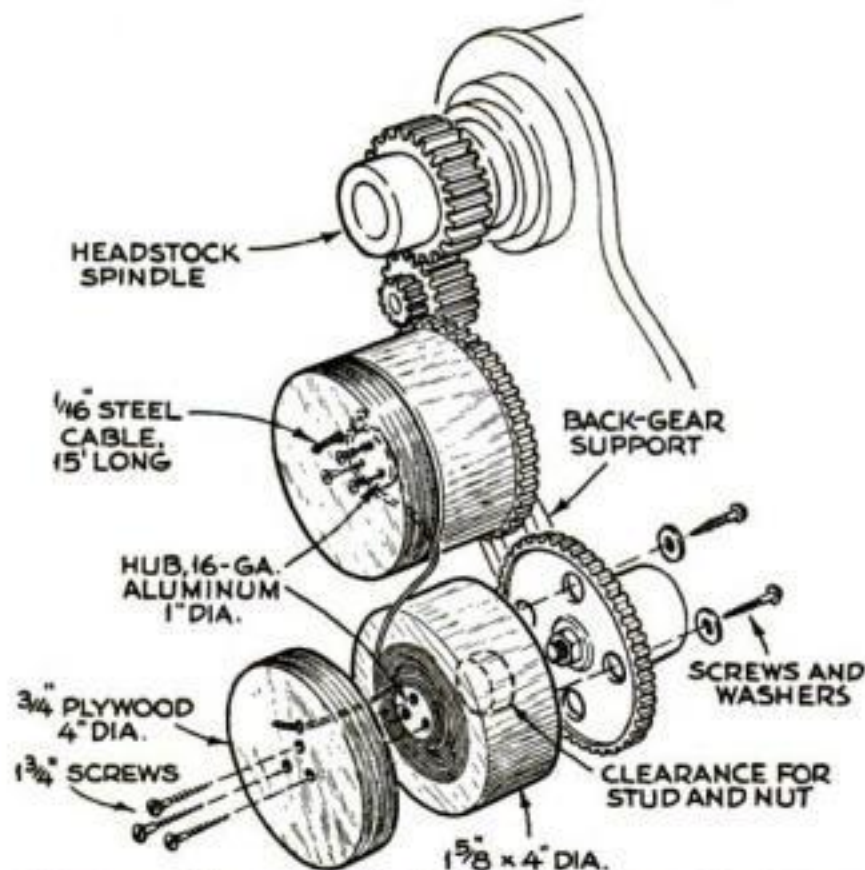
Here's How Those Threads Were

Cut (See preceding page)

EVER rewind movie film and notice how the rear reel starts slow, turns faster as film builds up on the take-up reel?

Two drums wound with steel cable work the same way to increase the speed of the lathe lead screw while the thread is being cut. Each drum is made in three parts: a 4"-diameter disk cut from two-by-six, a similar disk of ¾" plywood, and a 1"-diameter hub of 16-gauge aluminum fastened between the two to form a groove in which 15' of 1/16" cable will wind over itself. Bolt the drums to the largest back gears and install on the lead screw and driver studs.

Start with all the cable wound on the lead-screw drum and run the lathe at slowest speed. Feed the threading tool into the rod or bolt being threaded and



advance the cut slightly as threading progresses so that the larger threads will be proportionately deeper. As the cable winds onto the driver drum, its diameter will increase, and the diameter of the wound cable on the lead-screw drum will decrease, causing the lead screw to rotate faster. This increases the thread pitch.

HOW TO CHOOSE AND INSTALL Radio Controls for the Model Savannah

Part IV. Start, stop, steer, and reverse the ship from shore with a no-license, citizens-band transmitter

By Howard McEntee

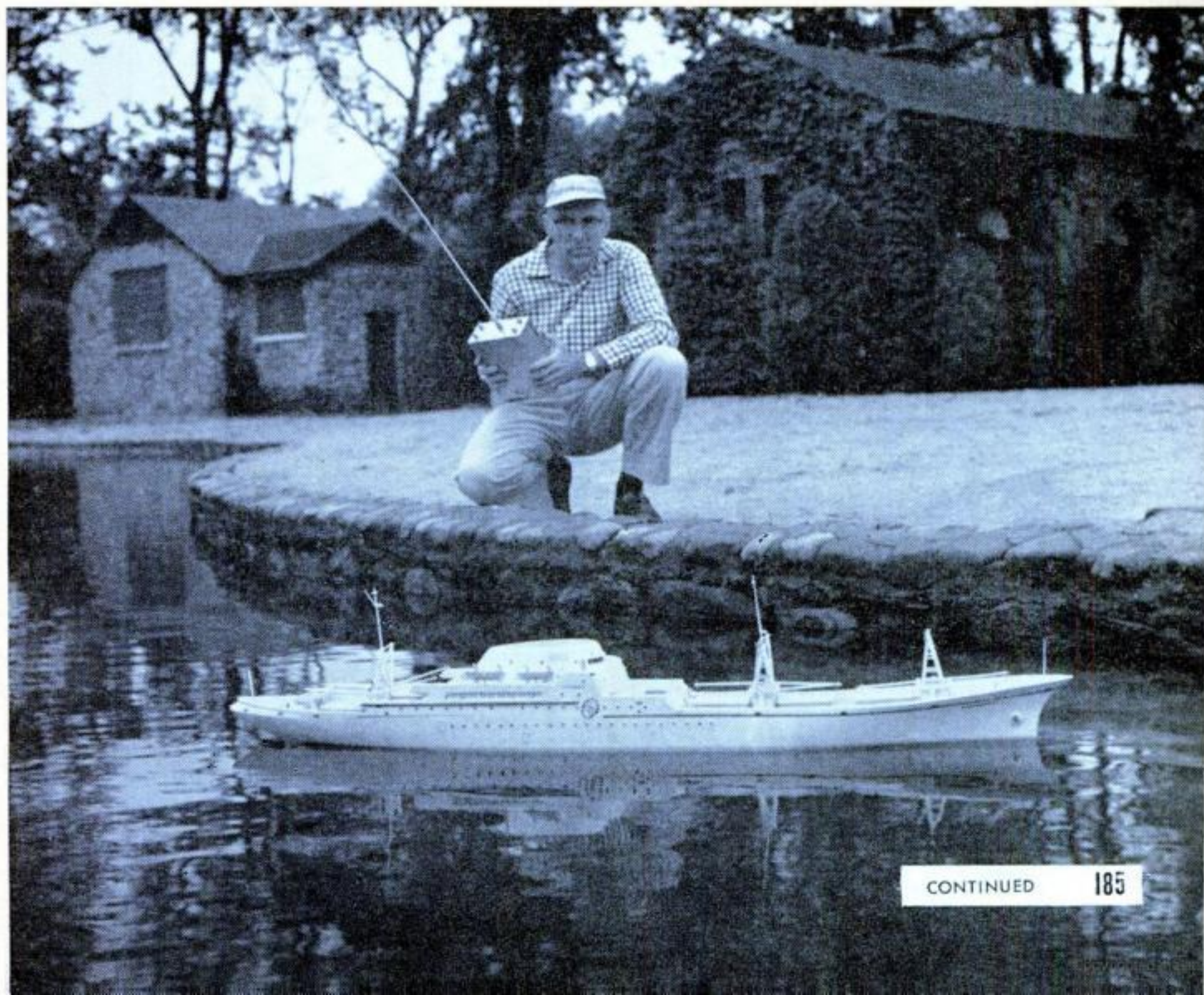
WITH a winter's shipbuilding work behind you, and the feel of spring in the air, you're ready for the final step—installing radio controls in your model.

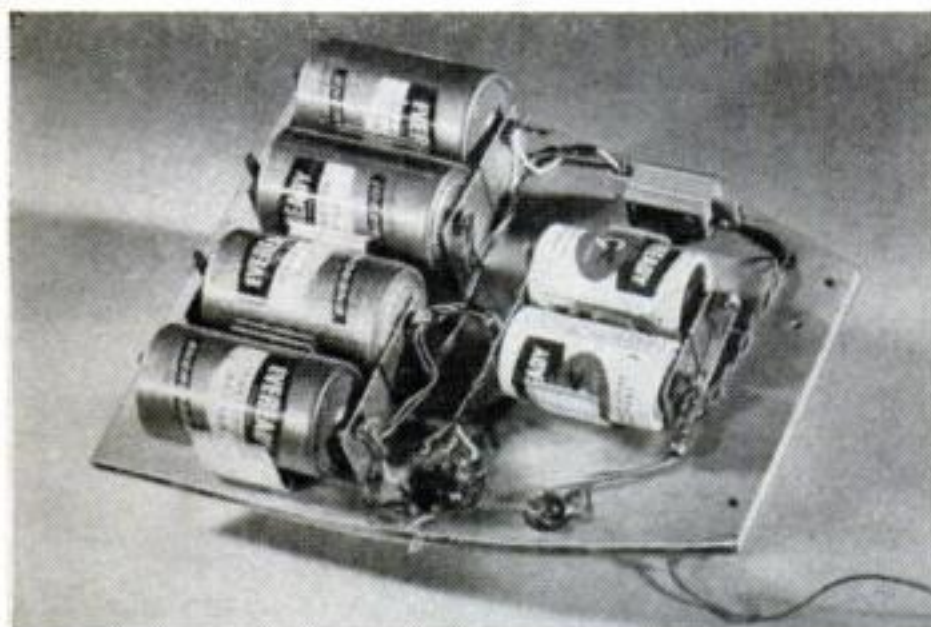
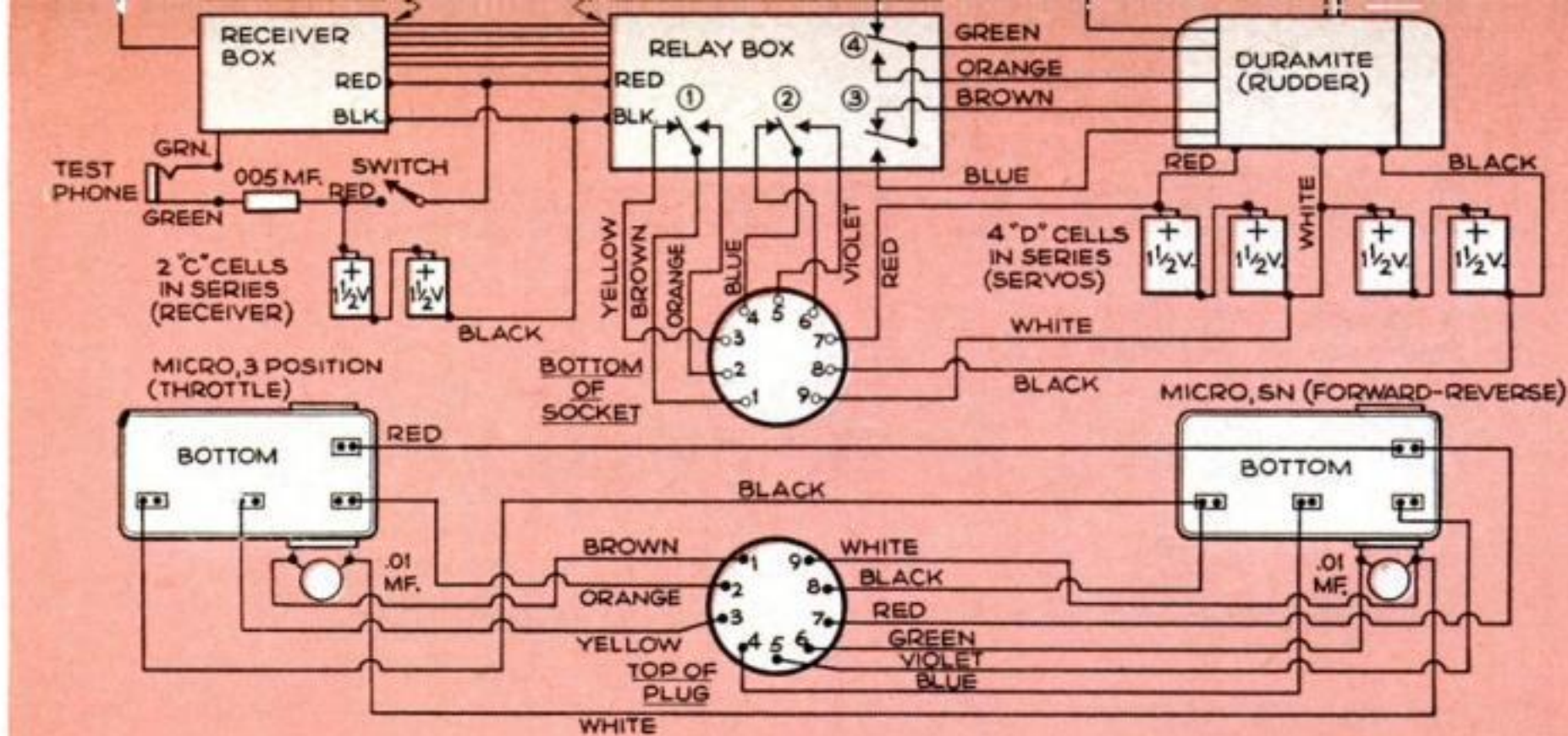
Any shore beside quiet water can be your navigation deck. The ship's helm and engine-room quadrant are in a compact radio transmitter you can hold in your hand. Inside the ship are the engi-

neers—tiny obedient servos that respond to signals sent by the transmitter.

In selecting your radio-control equipment, you must balance what you want the ship to do against how much you want to spend.

At the low end of the price range, with a single-channel CW (continuous wave) kit costing about \$45 you can run one servo through a sequence of four simple controls, such as forward, right rudder, reverse, and left rudder. The disadvan-





SIX DRY CELLS supply power for the equipment in the ship. Four D cells operate the servos; two smaller C cells energize the radio receiver. Wiring goes through a nine-pin plug to receiver and servos on the other side of the plywood base.

Cost of Typical R/C Outfits

Equipment	Single Channel	Four Channel	Type Used by PS	Ten Channel
Transmitter	\$20.00	\$120.00	Min-X	\$120.00
Receiver	20.00	Incl. with transmitter		150.00
Tuning earphone	—	1.50	Crystal	1.50
Tuning meter	4.50	—	—	—
Tuning tool	.50	.50	Hex	.50
Switch, wire plugs, & socket	2.00	3.00	See text	4.00
Receiver bats.	3.50	.50	Two C cells	.50
Trans. batteries	5.00	5.00	A and B	5.00
Steering servo	11.00	13.00	Duramite	13.00
Fwd.-Rev. servo	10.00	10.00	Cobb Micro SN	10.00
Throttle servo	—	10.00	Cobb Micro 3-position	13.00
Servo batteries	1.00	1.00	Four D cells	1.00
Battery holders	2.00	1.50	Three spring clips	1.50

tage, of course, is that you must go through the first three controls to get to the fourth, resulting in slightly erratic operation of the ship.

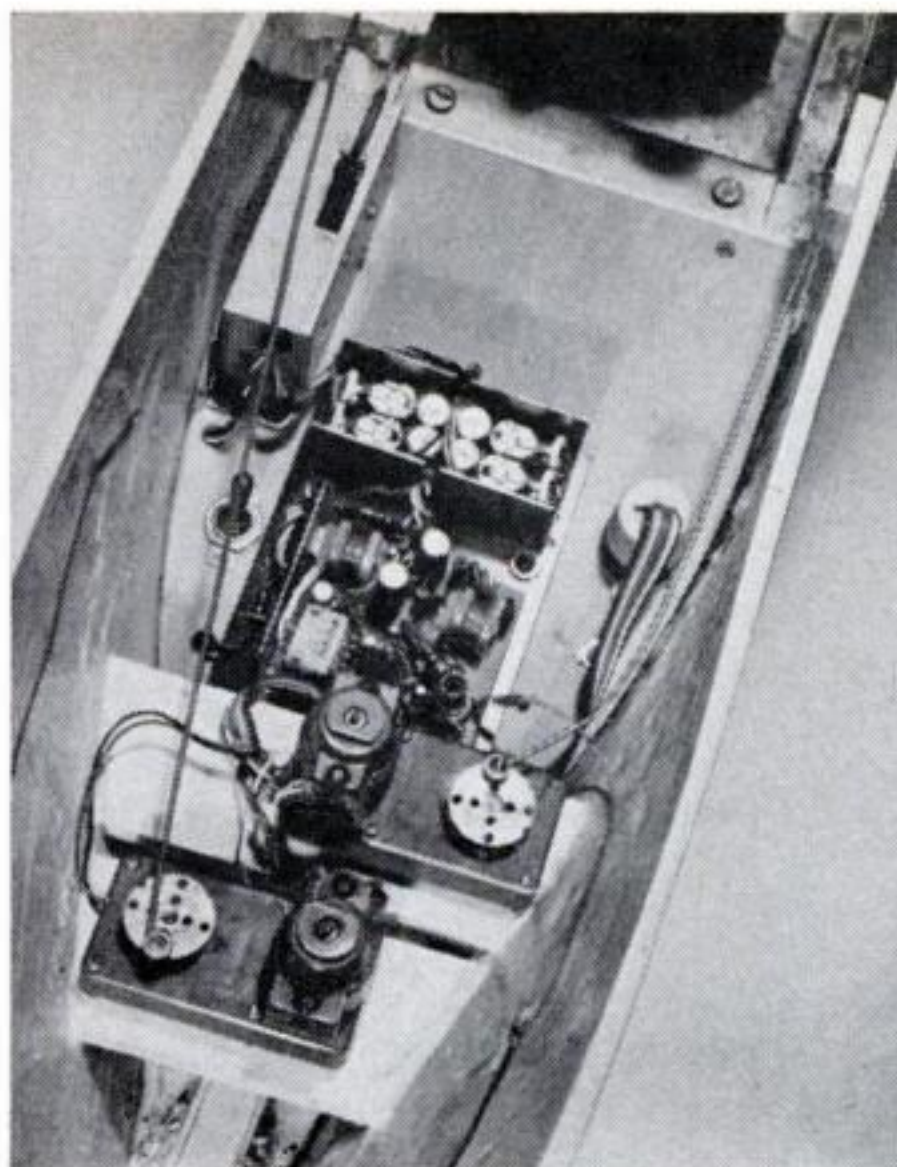
At the opposite extreme is a \$300, 10-channel rig that will permit separate steering, full control of throttle and reverse, plus the luxury of being able to drop and raise anchors, turn on lights, lower lifeboats, and blow a whistle. You can even put in a small tape recorder and play the busy sounds of a harbor as your ship comes into port.

The R/C rig illustrated is a four-channel tone outfit costing about \$165. It permits steering in either direction at will, plus independent forward and reverse, and throttle control at off, half, and full positions. With this setup you maintain precise control of the ship and eliminate the tricky key work necessary to run through a continuous sequence of operations on a single channel. A breakdown of costs is given at left so you can compare the low-, medium-, and high-priced outfits. By buying kits instead of assembled equipment, you can save at least 25 percent.

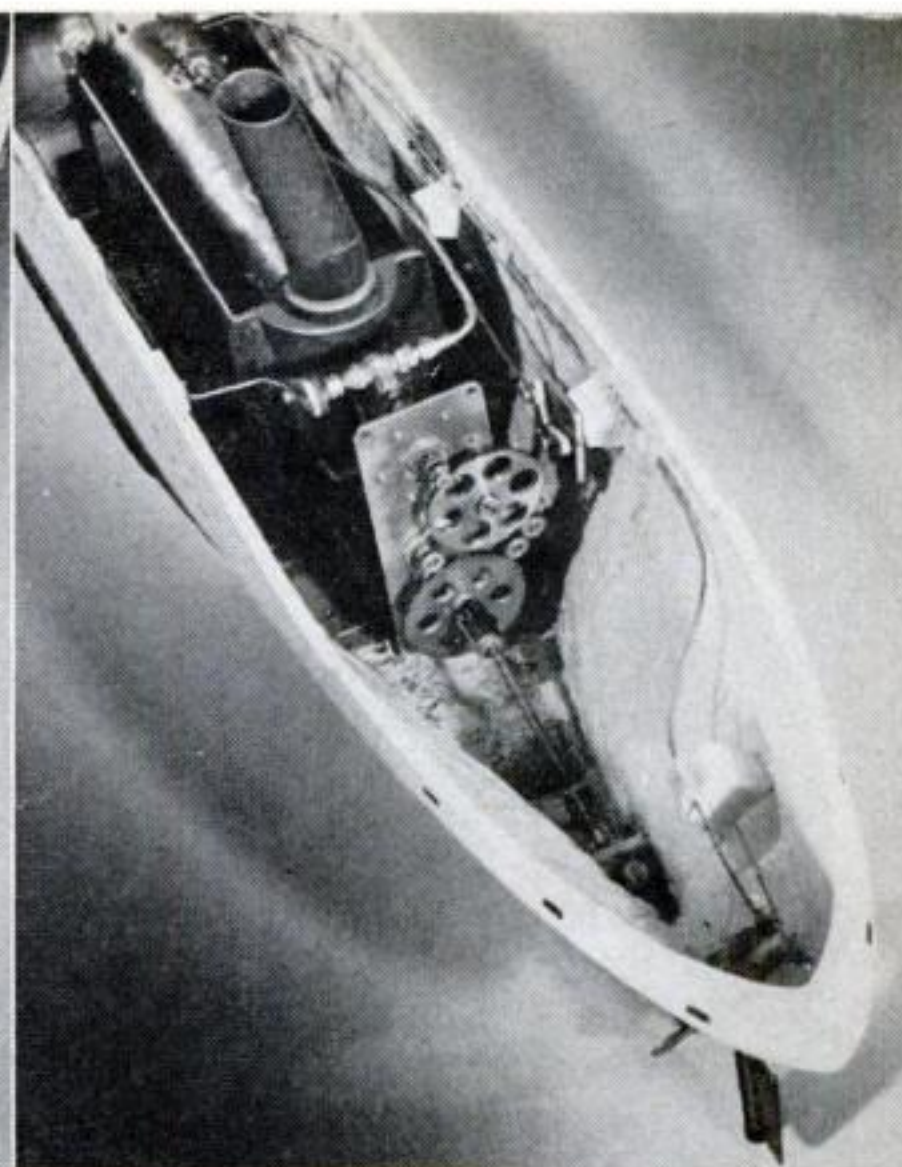
Installing the receiver. Hook up and install the receiver first, following instructions that come with it. Cement the two parts of the receiver to a plywood base. To the underside of the base cement a layer of foam rubber to cushion the delicate receiver against vibration. Finally, fasten it down by cementing the foam rubber on top of the main base in the hull.

Screw holders* for the three sets of

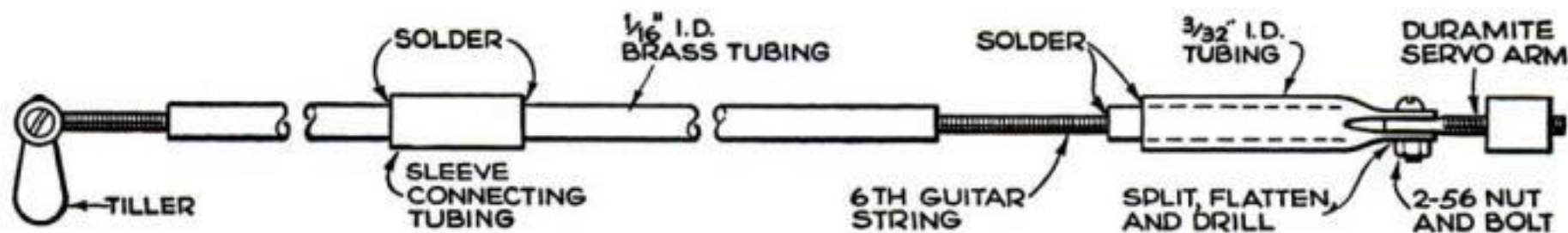
How radio controls run the Savannah



RECEIVER AND SERVOS are installed near bow, away from heat of boiler. Covers are removed from two parts of receiver in photo at left to show four relays (one for each channel) and receiver itself. Disks on two forward servos



rotate to move push rods connected to throttle and reverse. Arm slides back and forth in servo (top left of photo) to steer rudder through flexible cable. The picture at right shows push rods and flexible cable terminating at controls.



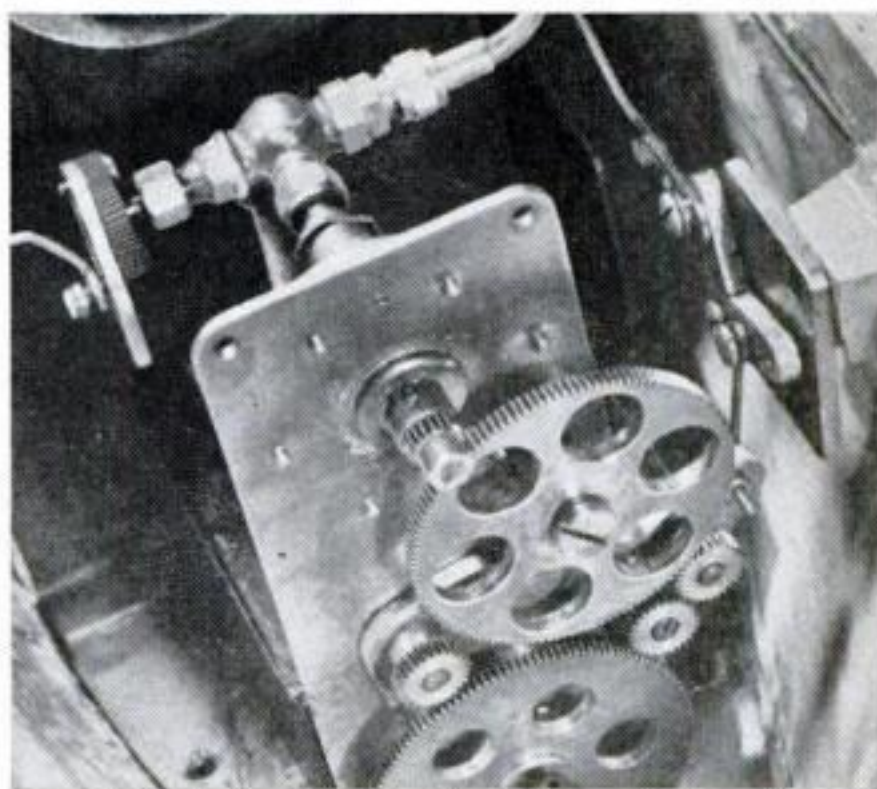
SMOOTH-WORKING FLEXIBLE CABLE can be made from a guitar string housed in 1/16"-i.d. brass tubing. Hobby shops sell the tubing in 1' lengths, so two lengths must be joined with a sleeve, as shown above, to reach the rudder.

dry cells to the underside of the main base. This places the weight of the batteries at the lowest point in the hull, to keep the ship stable.

A nine-pin plug and socket connect the batteries on the underside of the base to the receiver and servos above. Follow the color coding in the wiring diagram and complete one circuit at a time through the plug.

An on-off toggle switch on the base shuts off the receiver. No switch is needed for the servo D batteries as all servo circuits are open when the receiver is off.

A small jack, also mounted on the



GEARS ARE REVERSED when servo push rod moves bell crank (at right in photo). Push rod at left swings metal arm on valve wheel to Off, Half-Open, and Full-Open positions, depending on signal sent from the transmitter.

CONTINUED

base, enables you to plug in an earphone for accurate tune-up of the receiver. A .005-mf. condenser soldered into the wire running to the jack keeps DC from damaging a crystal earphone.

The servos. Install the plastic Cobb servos up near the bow, away from the heat of the boiler. Fasten a shelf across the hull with epoxy glue and screw the servos to the shelf. Screw the metal Duramite servo on the baseplate that supports the receiver.

Two types of linkage were used to connect the servos to the operating parts. A flexible cable consisting of a "sixth" guitar string housed in a length of $\frac{1}{16}$ "-i.d. brass tubing connects the Duramite servo to the tiller on the rudder post. Operate the servo to determine its throw and drill a hole in the tiller far enough out from the post to make the most of the servo action.

The forward-reverse servo moves a stiff wire push rod connected to a bell crank mounted on the hull side above the

reverse lever on the gear train. Since the servo throw is greater than needed to bring the gears into mesh, a slotted brass plate is soldered to the bell-crank end of the push rod. Make the slot long enough to waste part of the throw yet bring the gears firmly together. Small staples driven into wood blocks cemented to the hull sides guide the push rod and keep it from buckling.

A similar push rod links the throttle servo to a metal arm fastened to the fiber handwheel on the globe valve.

The antenna. Tape a 2' length of hook-up wire to the inside of the hull and solder one end to the antenna lead on the receiver. This has given ample sensitivity for all test runs that have been made—some more than 100 yards from the transmitter. If you want to run your model until it's almost out of sight, better string fine wire from the masts to serve as the antenna. Run an insulated wire down the forward mast and through a hole drilled in the deck to connect it to

An Electric Motor Can

YOU can take the easy way—and save money, too—by powering your Savannah with a miniature electric motor. With it, you won't have to fire up a head of steam each time you run the model.

Glue a $\frac{1}{4}$ "-plywood platform in the hull bottom, and fasten the motor, battery, and control switch on it. Raise the motor on wood chocks to align it with the propeller shaft.

Glue wood strips to the platform to keep the battery from shifting, and hold it down with a heavy rubber band stretched between two screw-eyes.

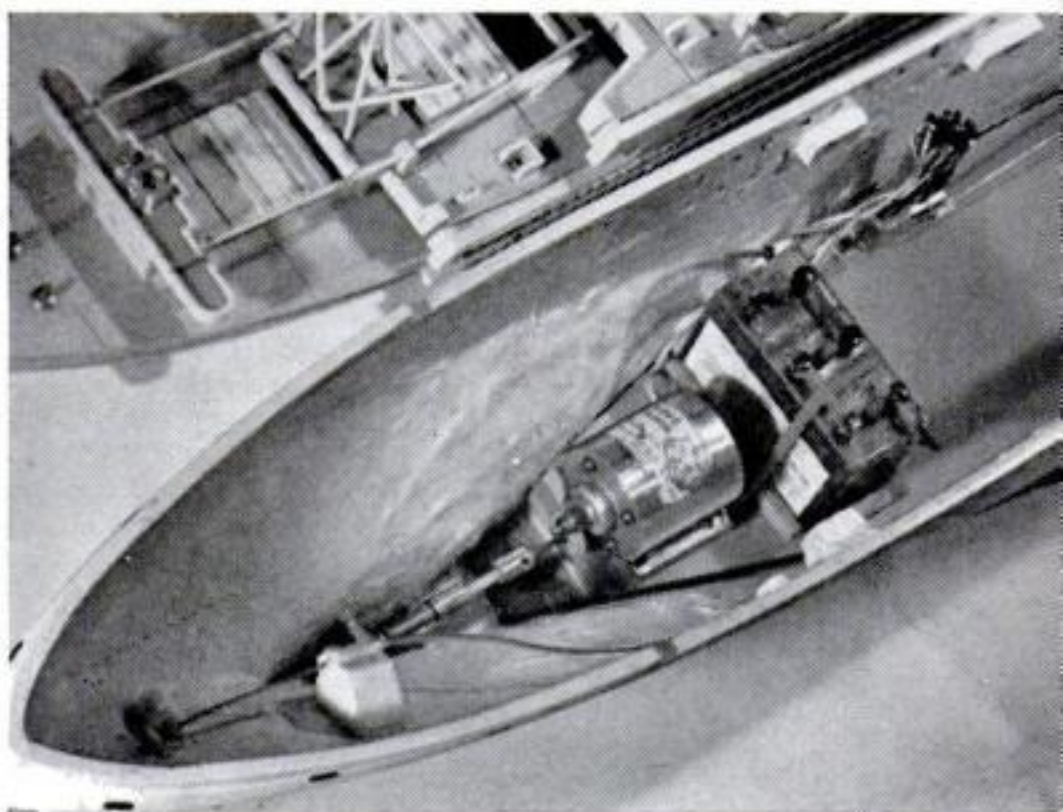
A four-channel radio control, similar to the one used for the steam installation, directs the electric drive. One channel actuates a Cobb three-position servo linked to the telephone switch by a push

rod. Keying the transmitter in sequence switches to forward, reverse, and off.

Two channels control steering, permitting left or right turns at will.

As a final touch, a small horn can be

Parts Used for Electric Drive	App. Cost
Sterling King Beaver motor #KB-695	\$6.95
Beaver #KB-75 reduction gear	.75
Pittman #7502 flexible coupling	.60
Aristo-Craft #64 battery	4.75
Aristo-Craft B-1 horn kit	.35
Telephone switch (Lafayette Radio)	.69
Two ceramic condensers, .01 mf., 300 v.	.40



MOUNT THE MOTOR on chocks to align it with the prop shaft. A universal joint compensates for slight misalignment between the two. Battery is a six-volt wet cell. It will run the motor for about two hours and can be recharged with a small trickle charger or a DC model-railroad power pack set to put out six volts.

the antenna lead on the receiver. Solder this connection for good contact.

You can test the controls by having someone stand by the ship while you walk away with the transmitter. Call out your signals as you send them so the observer can check as they are received. To test the effective range, take the ship out of doors and send signals as you walk away.

Continue widening the gap until the observer reports that the servos fail to respond to the transmitter; then walk toward the ship until it again responds. This will give you an idea of the limit of your control and prevent accidental loss of the priceless model.

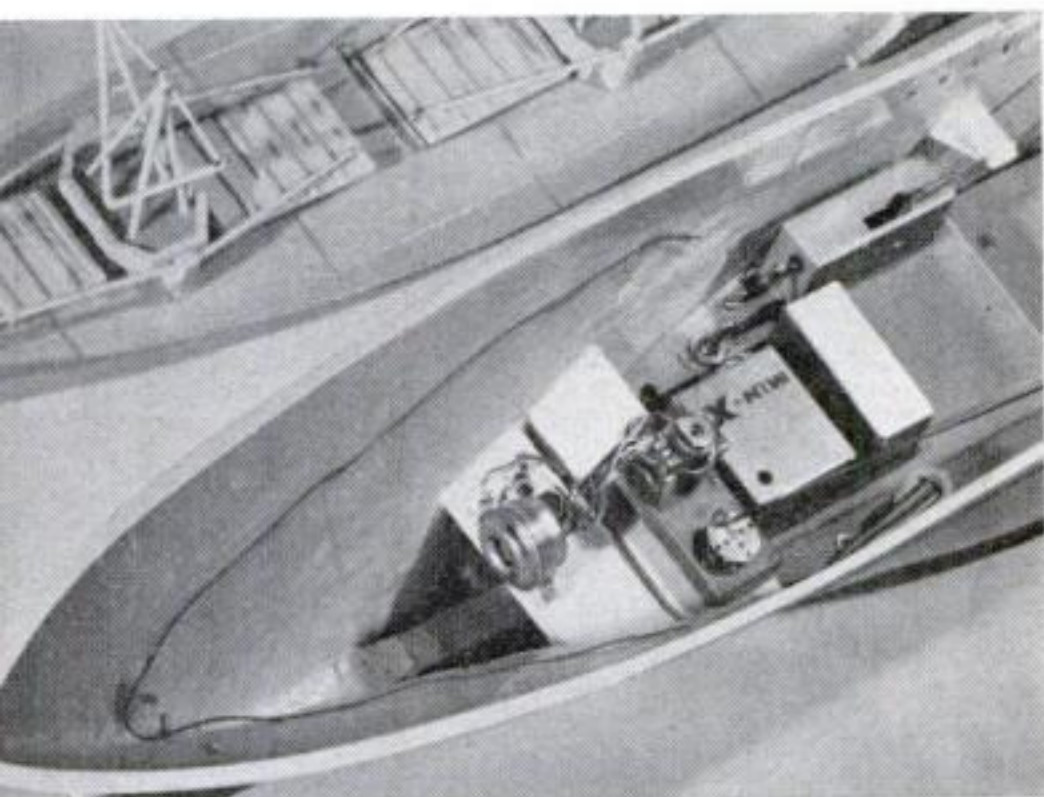
Although the transmitter and receiver are tuned at the factory, retuning sometimes brings a slight increase in range. Any high-impedance earphone can be plugged into the tuning jack to tune for the loudest tone. Instructions for tuning are included with all R/C outfits. Save them for future reference.



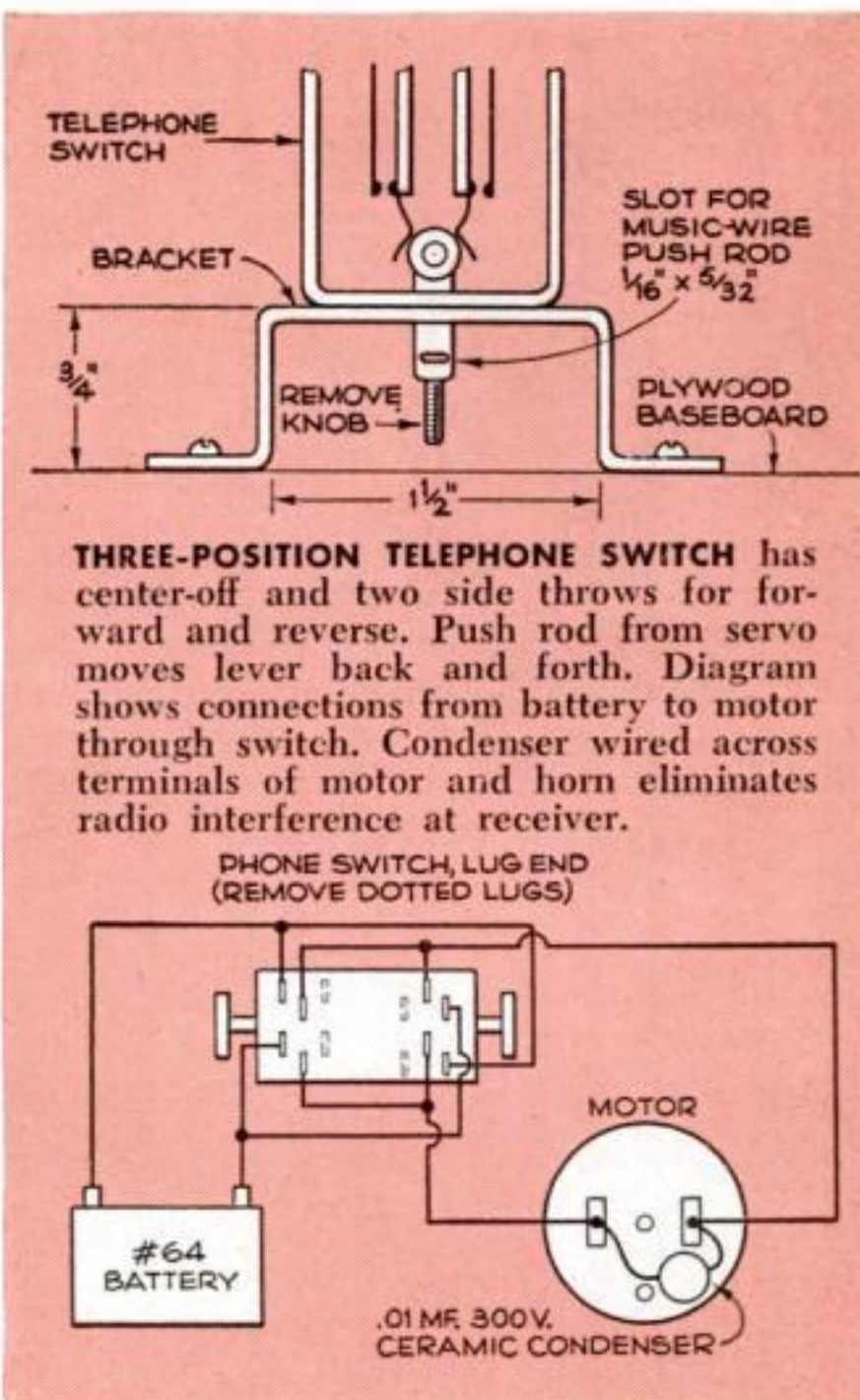
CHECK RADIO CONTROL before putting the ship in water to be sure of positive response and sufficient range. Here McEntee is tuning transmitter for strongest signal. Rig shown has four tuning screws at the top of the case.

Drive Your Model

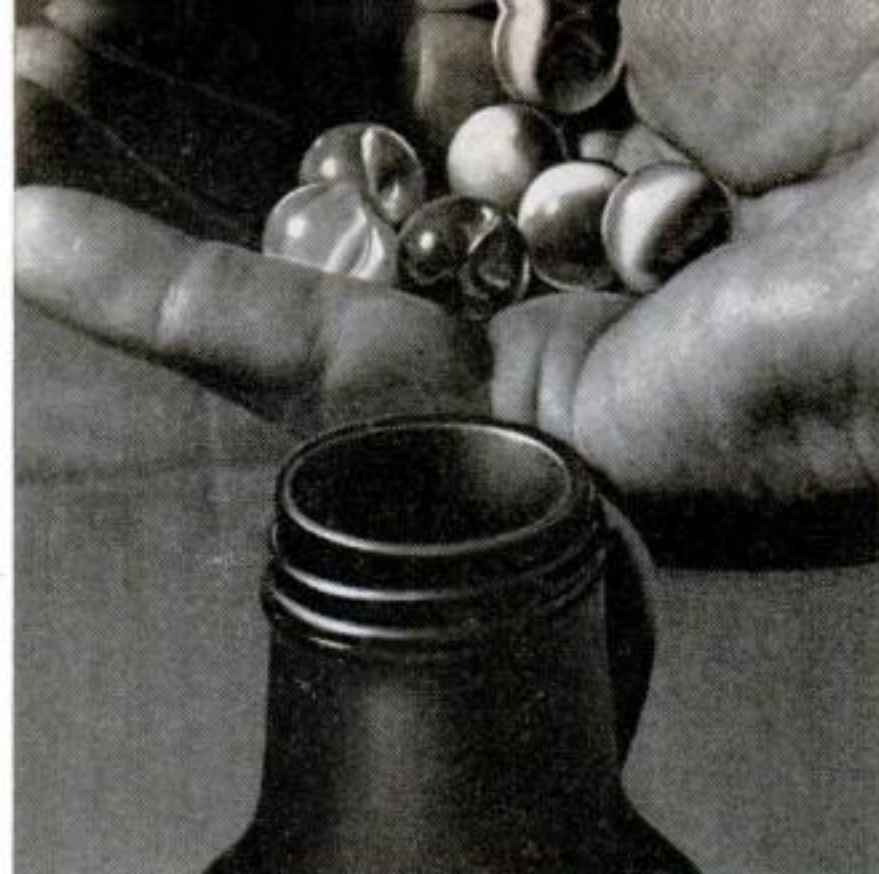
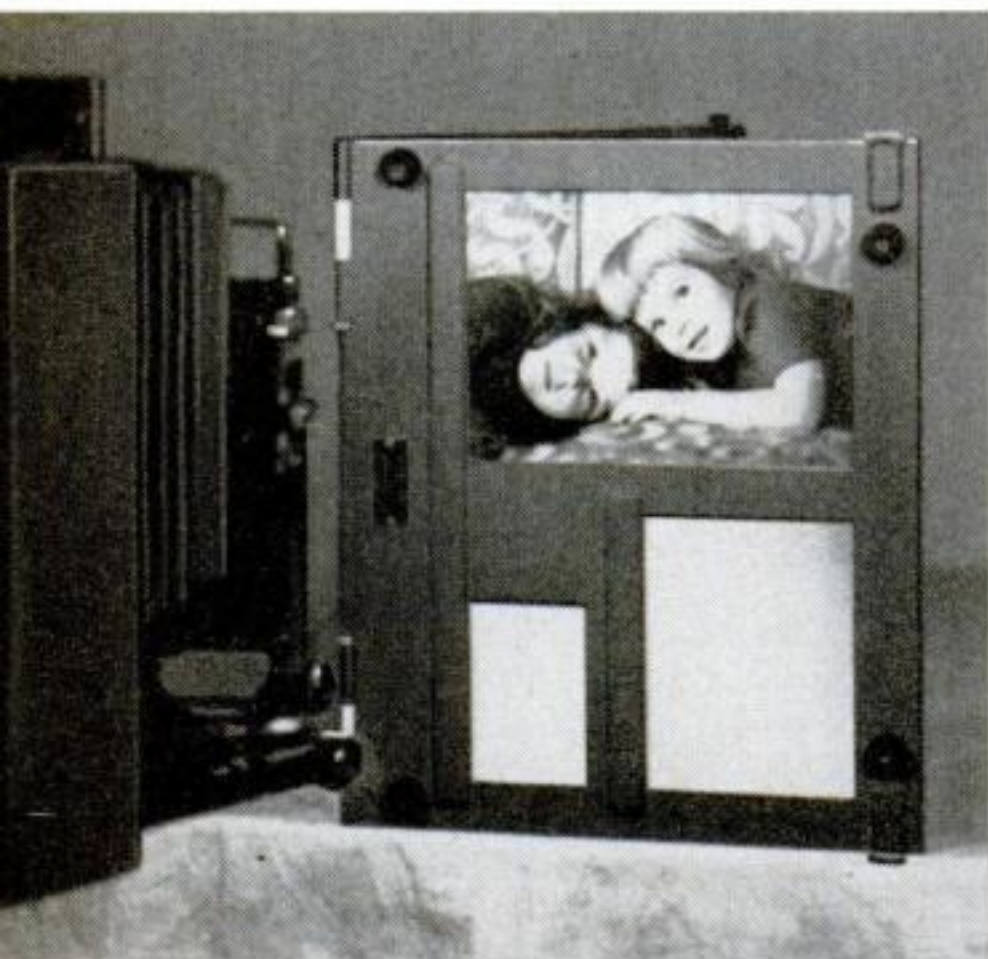
connected to the fourth channel relay. Keying the transmitter actuates the relay and closes the circuit to blow the horn without need of a servo. Lights can also be controlled by the relays.



RADIO-CONTROL SETUP is the same as the one used for steam installation, except that only one rotary servo is used to control the motor. A small horn, installed in place of a second rotary servo, can be blown by keying the transmitter to close the relay that controls the horn. Rudder control remains unchanged.

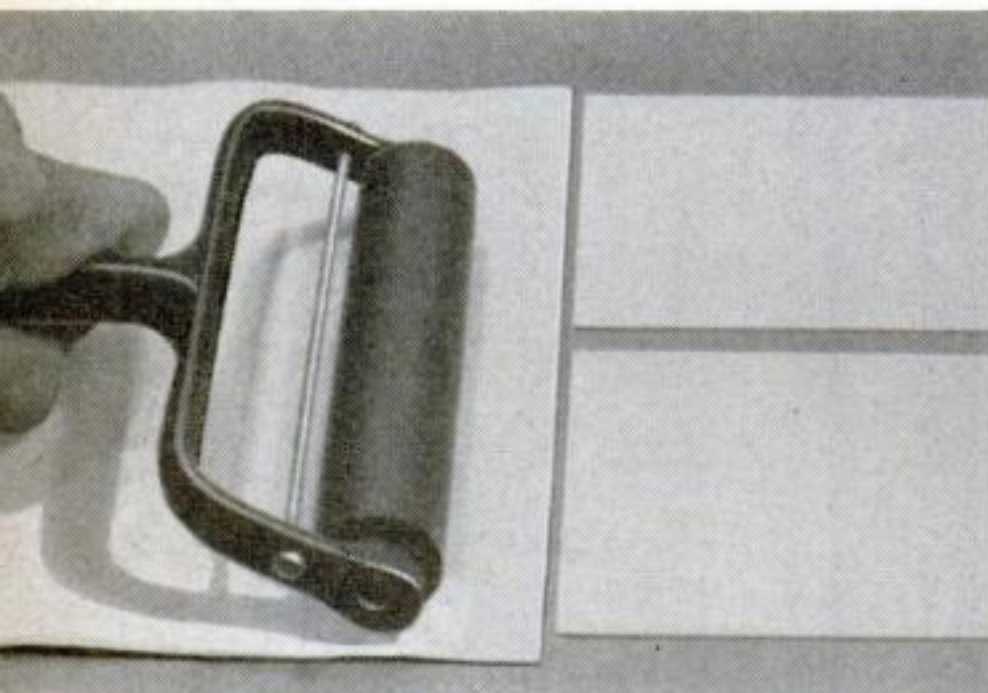


Short Cuts for Camera Men

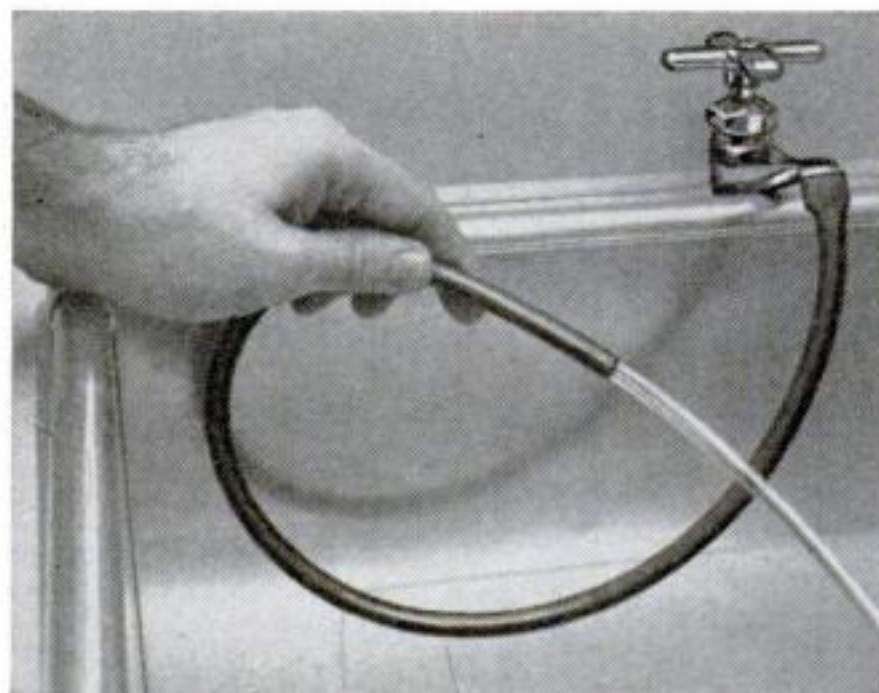


MIXING MAKESHIFT. When a large-mouth container isn't available for mixing chemicals, you can do the job with an ordinary bottle and a few marbles. Just drop in the marbles and shake the jar.—*Wayne Floyd, Fayetteville, Tenn.*

COPY HOLDER: An easel doubles nicely as a copy holder. Or at least the type shown at left does. The opposite (8-by-10) side is opened to hold the easel up straight. Reverse it for a larger print.—*W. D. McAllister, NYC.*



SHORT OF TINS? Ever print a large batch of glossy prints and find you haven't enough ferrotype plates? Roll the extras on a plastic kitchen-table top. Wax and polish the top first.—*Robert Micals, Freehold, N. J.*

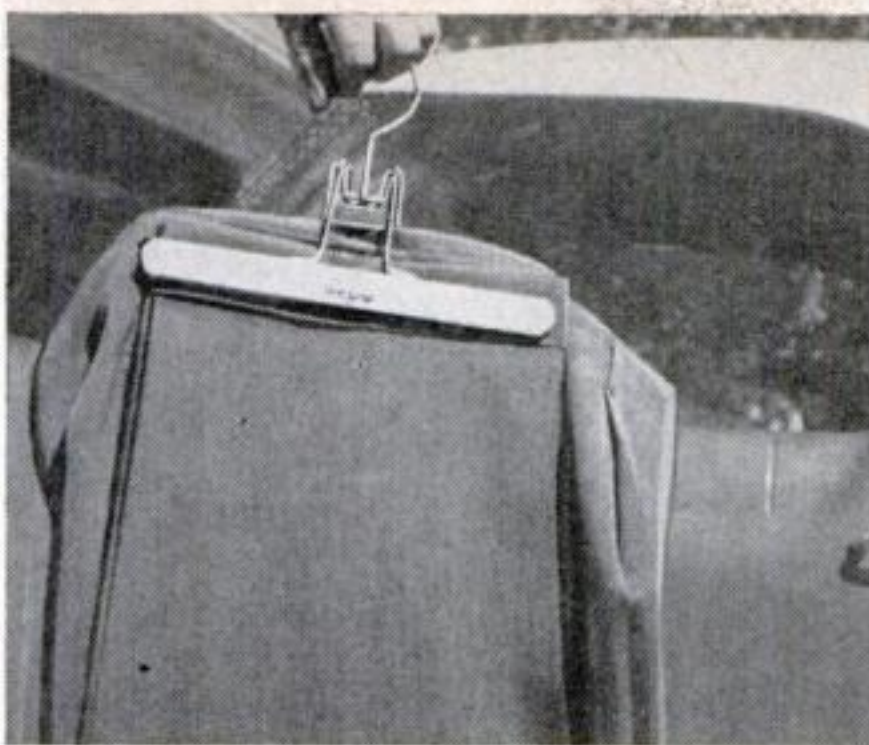


FAUCET HOSE: A piece of $\frac{3}{8}$ " syringe tubing from a drugstore makes a fine hose for a dark-room sink. It can be slipped into the center of many developing reels for washing film.—*Joseph R. Noonan, Burlington, Vt.*

SWITCHING TITLES THE EASY WAY: It pays an amateur moviemaker to own a collection of hardware-store metal letters and a choice of

spray enamel in cans. That way it's easy to make new titles and even change color if desired.—*Arthur R. Tanner, Poughkeepsie, N. Y.*



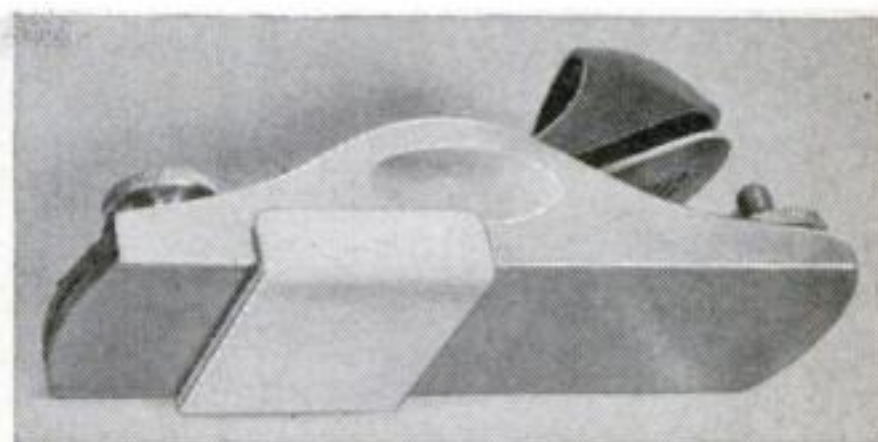


Creaseless Pants Hanger

TROUSERS carried in a car on an ordinary hanger end up with a sharp crease across them after a long trip. Avoid this by using a clamp-type hanger and clipping both cuffs and waistband. The pants will fold softly without creasing.—*Wesley C. McDonnell, Vancouver, Wash.*

Short Cuts and Tips

FROM PS READERS



Guard Protects Plane Blade

A PLANE banged around in a tool box with the blade exposed is sure to be damaged. You can protect the blade with a tight-fitting clip bent from 1/16" aluminum or brass. Pad the inside with cork or felt and soak it with oil to prevent rust.—*Robert Micals, Freehold, N.J.*

My Most Embarrassing Shop Moment

BOY, was I cocky! I had just finished my training as a streetcar operator, was sporting a smart new uniform, and looked—I was sure—like a million bucks.

Pulling out of the car yard on my first run, I noticed that the doors had failed to close. I pushed every button I knew and still they wouldn't close. I had to stop the car in the middle of the street and try to move the doors by hand.

They were double swinging doors, and as I gave them a yank they suddenly sprang at me. Before I could move, they had closed right around my neck. I couldn't move in or out. I was trapped.

My new cap fell in the mud. Crowds gathered. Finally, some people were able to pull the doors apart and let me out. The commotion had brought all my fellow operators and mechanics from the nearby yard and they were howling.

Luckily, the mishap didn't cost me my job, but I've been taking a stiff ribbing for years. Only now is it beginning to seem funny.—*William Bunton, Detroit.*



.....
Do you have an embarrassing shop blunder that haunts you? PS will pay \$50 for each such experience published. None can be returned. Keep it brief. Address: Shop Editor, Popular Science Monthly, 355 Lexington Ave., New York 17, N. Y.

Putting an Electric

By Sanford Maizel

NOTHING can give more scope to your ingenuity than a photoelectric relay. It can solve control problems in your most fanciful labor-saving schemes with an elegance that will delight the most gadget-loving soul—and prove reliable enough to fend off wifely skepticism.

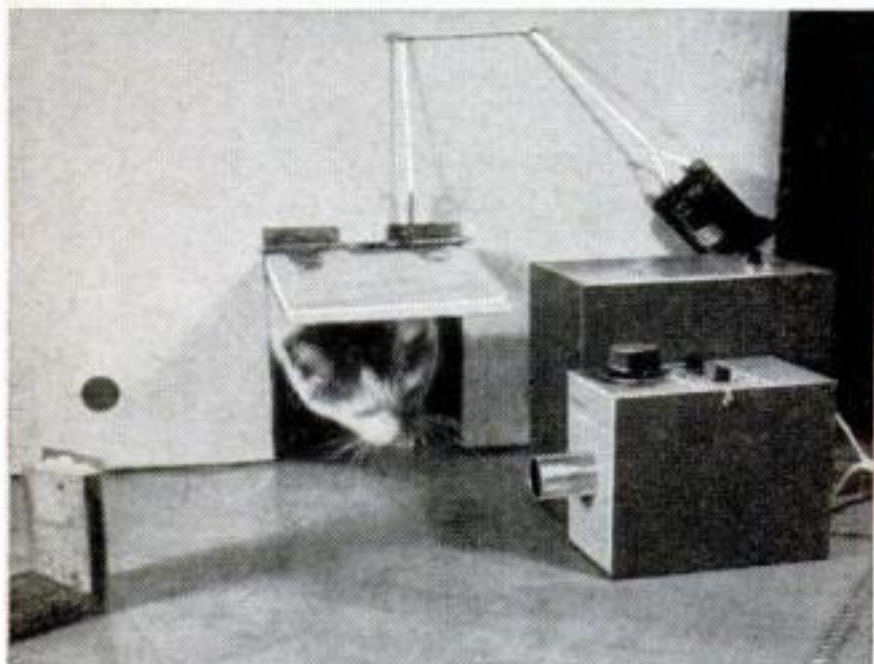
New developments in photosensitive devices have made possible the design for home use of photo relays that are more attractive than ever. One such is a kit-built job sold by Allied Radio (Knight Kit 83Y702, \$12.95). It's designed around

a tiny cadmium selenide photocell smaller than the eraser on your pencil. It's far more sensitive and requires less associated circuitry than the familiar tube-type photocell.

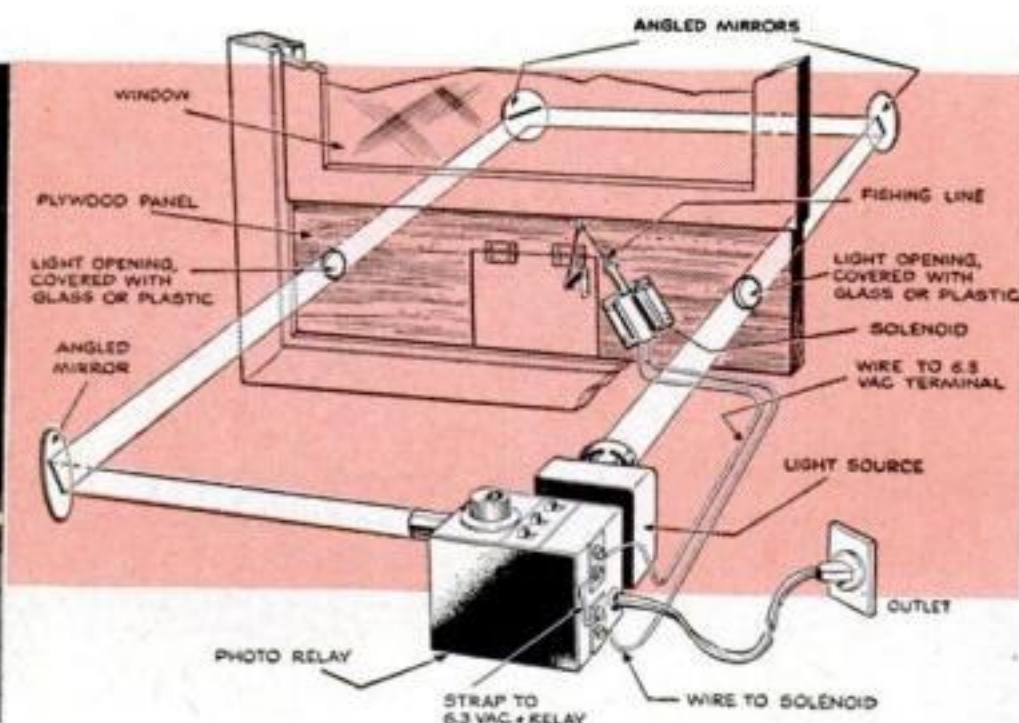
The kit makes a complete light-operated switch, plus a low-voltage power supply for direct operation of such things as bells and alarms. Also, connections to relay contacts are accessible for switching up to 1.5 amps at 50 volts AC from an external power source.

For switching 115 volts AC, you'll need an external relay. For convenience and safety, it's best to mount a power relay in a utility box and provide a stand-

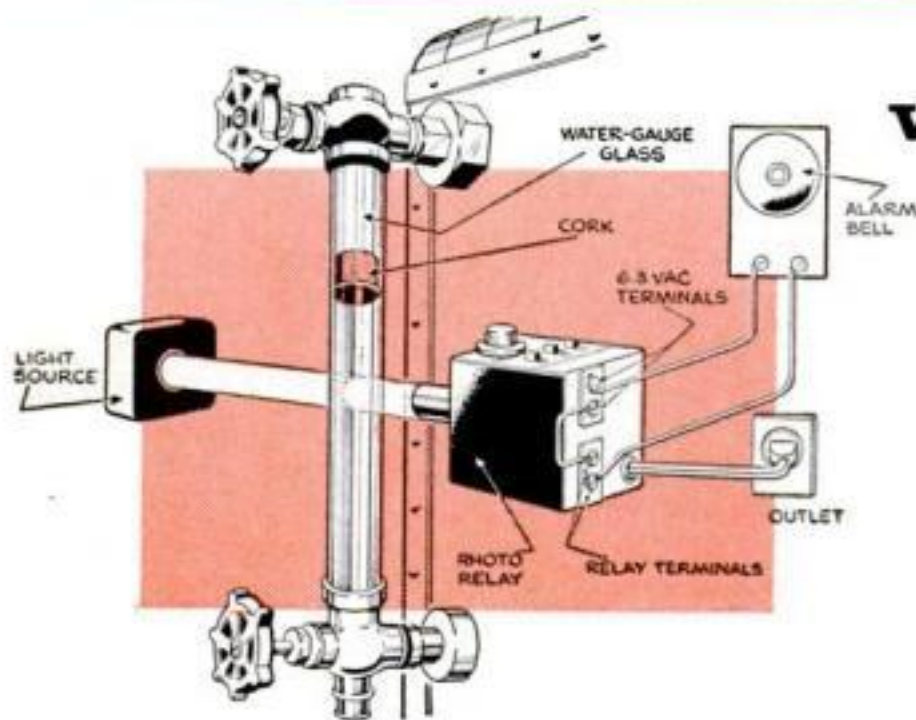
PET DOOR OPENER



THIS TIME AND TEMPER SAVER was installed in a plywood panel about 12" high, cut to fit the width of a ground-floor window. The hinged door is about 6" by 6". An "L" arm, fastened near the top of the door, is attached



to a solenoid by a short length of fishing line. A four-sided light pattern is arranged so that the beam will be broken and the photo relay will then be tripped from either the inside or the outside of the window.



WATER-LEVEL ALARM

MOST STEAM-HEATING BOILERS have a low-water cutoff to prevent damage to the boiler. But if you want a warning alarm that will remind you *before* the boiler water level gets critically low, you can easily rig one up.

Fit a cork loosely inside the water-gauge glass. Arrange a small light source on one side of the gauge glass and the photo relay on the other. Adjust the height so that the cork will interrupt the light when the water level drops. You'll have to mask the light source and photo eye to eliminate extraneous light. The alarm bell can be mounted upstairs.

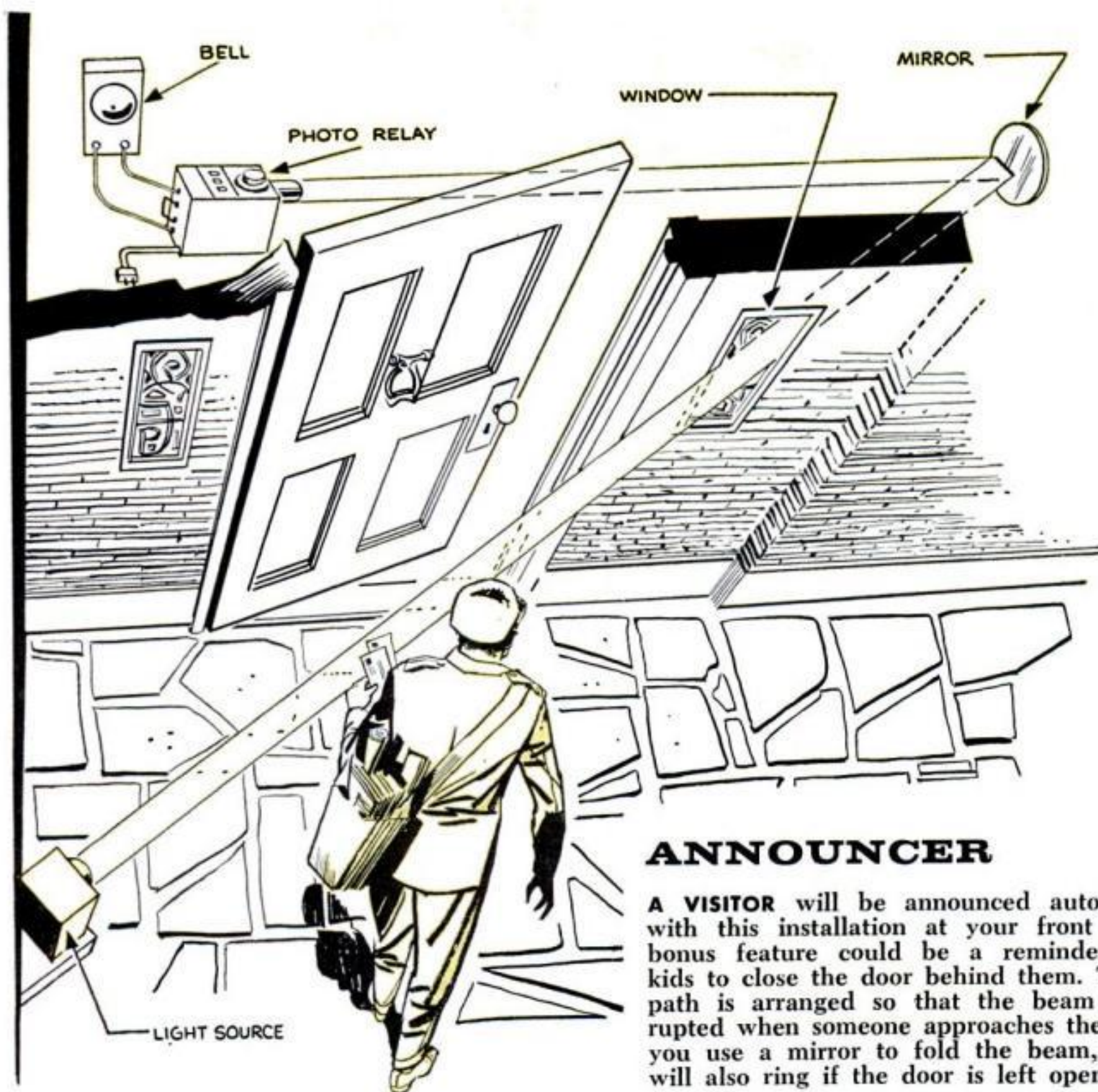
Eye to Work

ard line cord and plug-in receptacle. A diagram in the kit manual shows how.

The circuit controlled by the photo relay is open as long as light falls on the photocell. It's closed when the light is interrupted. By proper connection of the external relay, the action can be reversed. The maker claims the photo relay will make up to 600 counts per minute and is sensitive enough to operate from one-quarter foot-candle of light. Power consumption is only three watts. You'll have your own pet project for this versatile electronic servant, but here—on these and the following two pages—are some ideas to start you on your way.



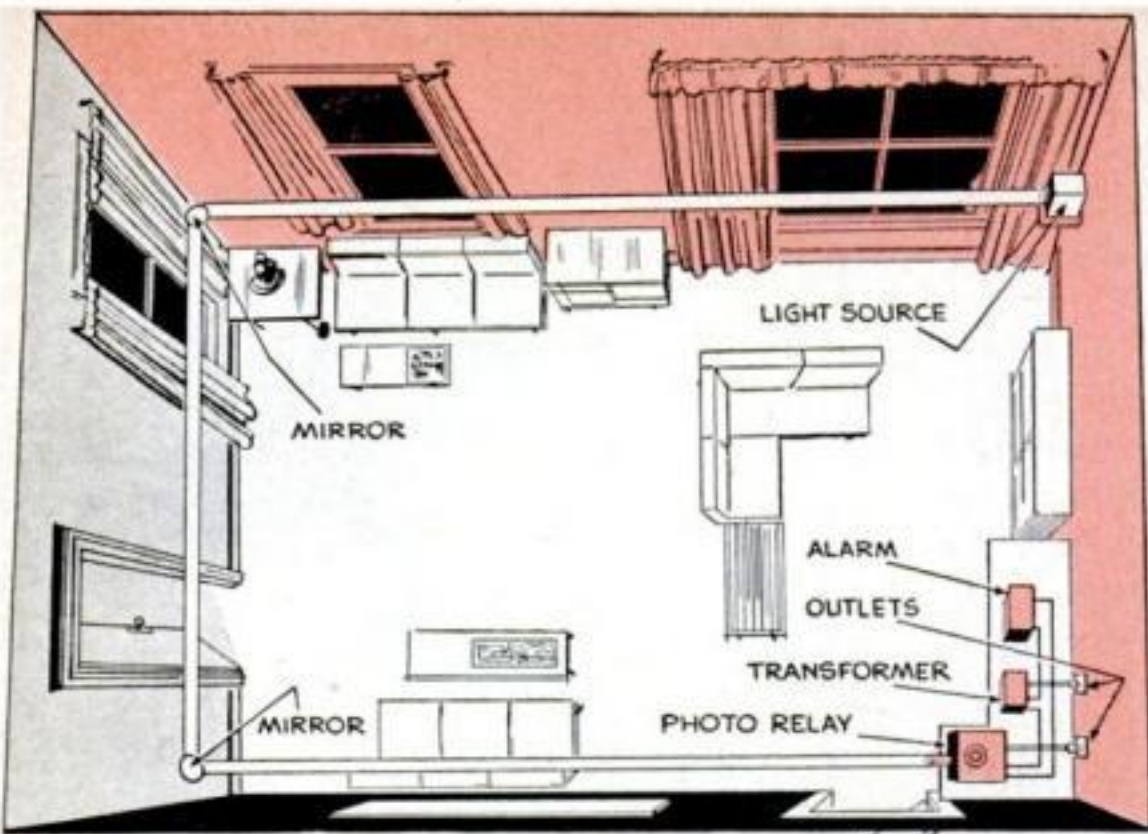
KIT-BUILT PHOTOELECTRONIC RELAY is completely self-contained. Tiny light-sensitive element is shown standing by shield. Knob on top adjusts sensitivity for varying light conditions.



ANNOUNCER

A VISITOR will be announced automatically with this installation at your front door. A bonus feature could be a reminder to the kids to close the door behind them. The light path is arranged so that the beam is interrupted when someone approaches the door. If you use a mirror to fold the beam, the bell will also ring if the door is left open.

CONTINUED

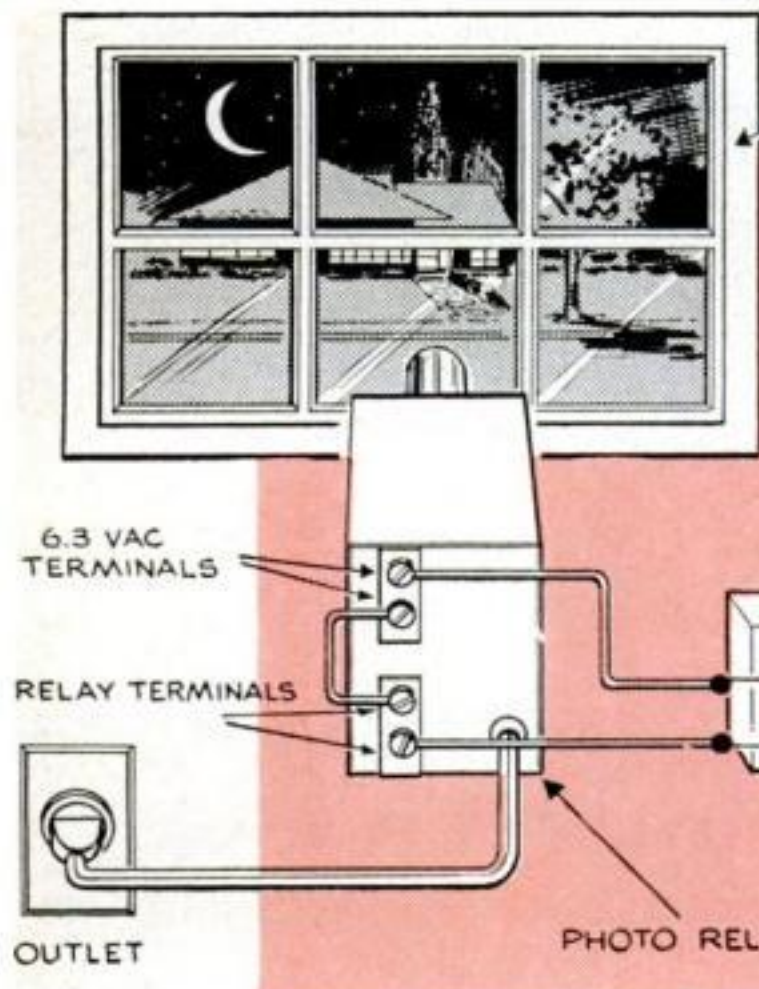
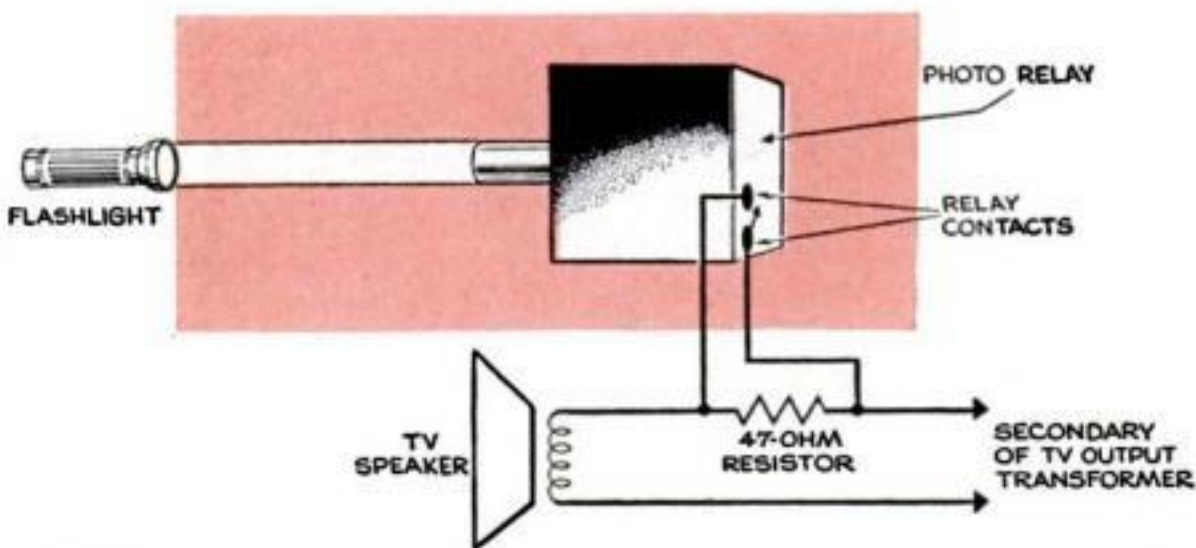


BURGLAR ALARM

A SIMPLE INSTALLATION using a light source and the photo relay will ring an alarm if anyone enters the protected area. A light path that crosses all windows and doors is created by use of mirrors. The switch on the photo relay is set to *trip*, so that the alarm will continue to ring once the light path has been interrupted.

TV-COMMERCIAL KILLER

MOUNT A MAILING TUBE over the relay aperture to exclude room light. Aim it toward your viewing chair. Adjust the sensitivity control until a flashlight aimed straight at it trips the relay. Connect a 47-ohm resistor in series with the speaker voice coil in the TV, and connect the relay as shown in the diagram. Now you can mute noisy commercials with the beam of the flashlight.



DUSK LIGHT SWITCH

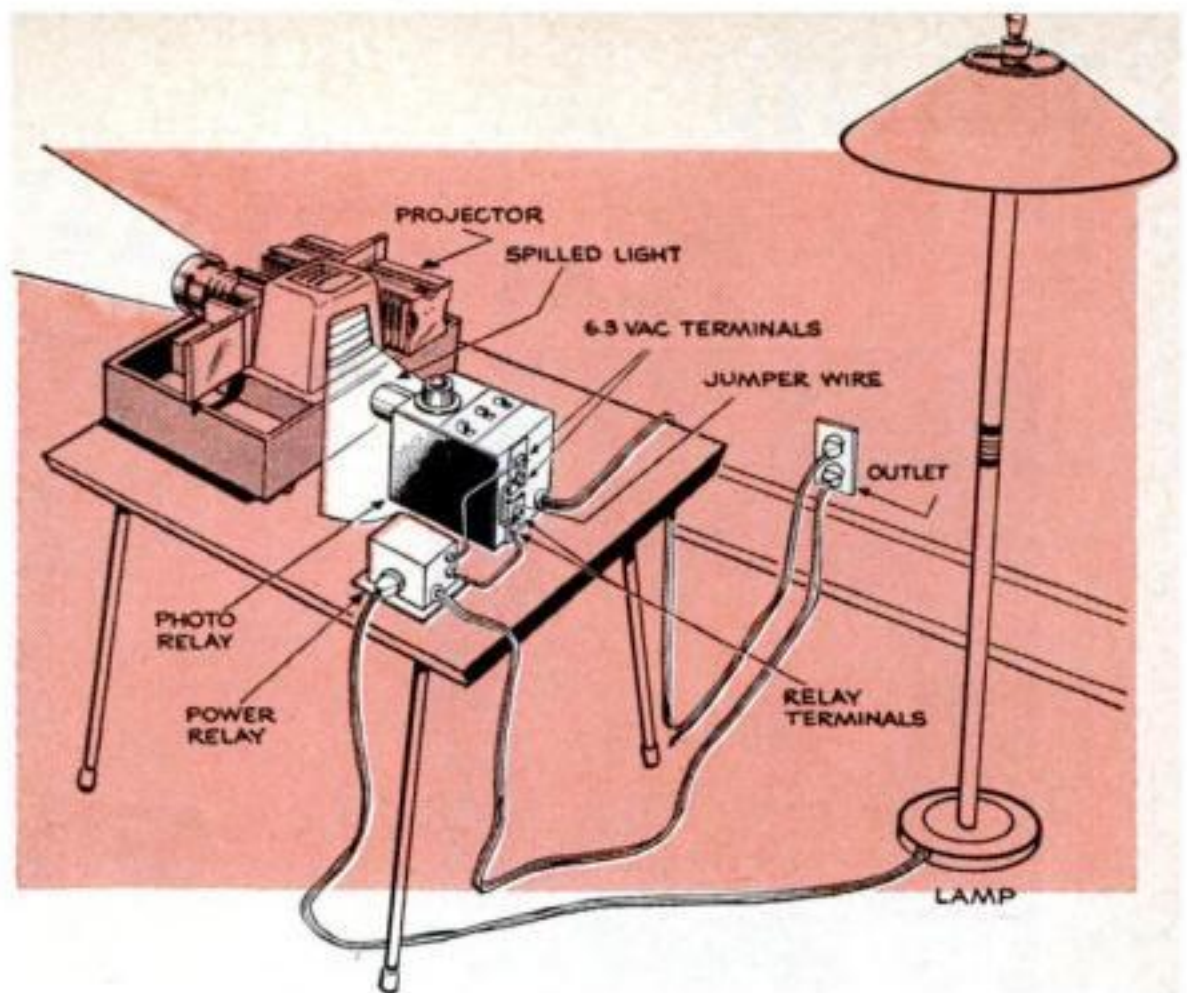
BURGLARIES occur far less often in homes that are, or seem to be, occupied. With the photo relay illustrated above it is a simple matter to have one or more lamps in the house go on at dusk and off again at sunrise—good protec-

tion when you're off on vacation. Just point the photo eye out a window, connect the power relay, and plug a lamp into it. Adjust the sensitivity knob so the relay operates at dusk and set the trip switch to *auto*.

PROJECTOR ROOM-LIGHT SWITCH

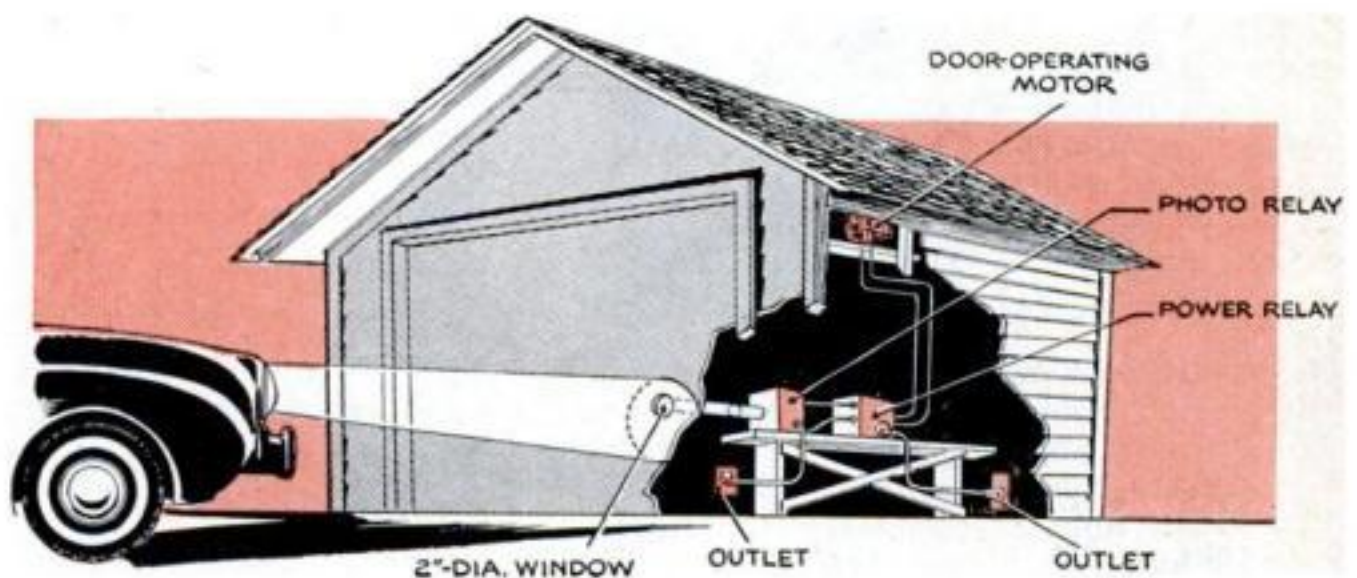
SLIDE OR MOVIE SHOWS for your friends are more fun if you can arrange for the room light to go out automatically when the projector is switched on, and come back on when the projector is turned off.

No special installation is needed. Just plug a floor lamp into the power relay outlet and position the photo relay to catch some of the light spill near the cooling vents in the projector-lamp housing.



GARAGE-DOOR OPENER

YOUR HEADLIGHTS will operate a motor-driven garage door and save you most of the cost of a radio-control unit. You'll have to experiment to find the best location for your particular setup. In general, you'll need to make about a 2"-diameter window in the door and position the relay so the beam from the headlights will reach it when the car is in a particular position. Since the low beam casts the headlights to the right, place the photo relay on a low shelf on the inside right-hand wall, as shown in the diagram. Use an external power relay that will handle the current required by the door motor. Connect the relay

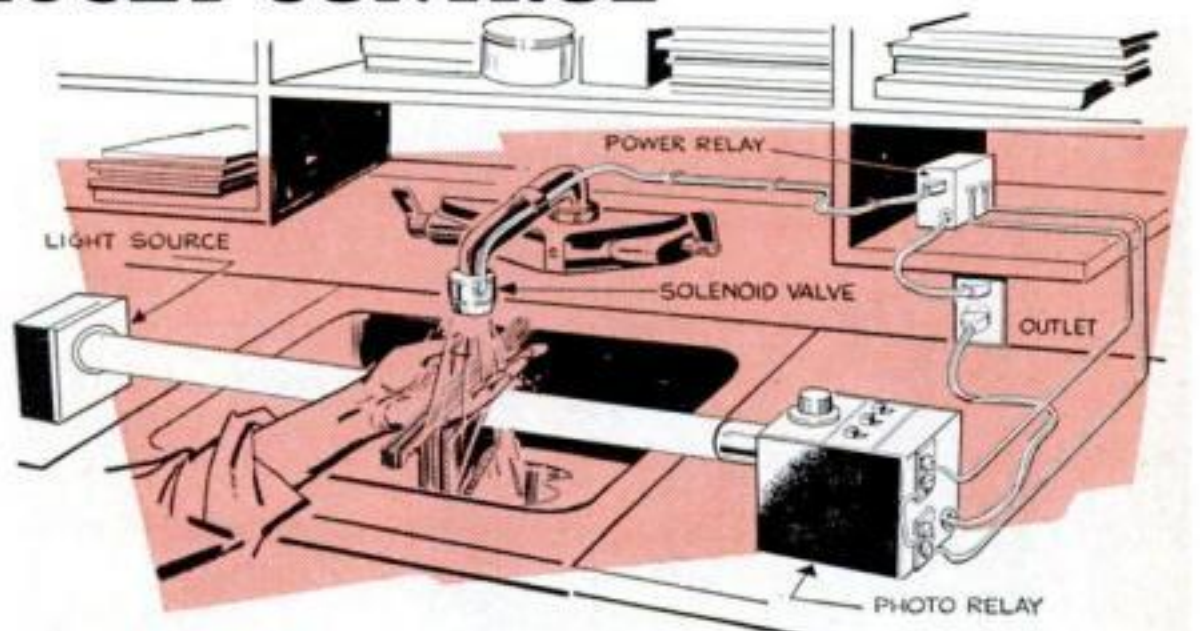


contacts so that the circuit to the motor is closed when light reaches the photocell. Use a length of mailing tube to limit the light reaching the cell to a narrow beam. Adjust sensitivity control until normal daylight will not trip the relay when the door is closed.

AUTOMATIC FAUCET CONTROL

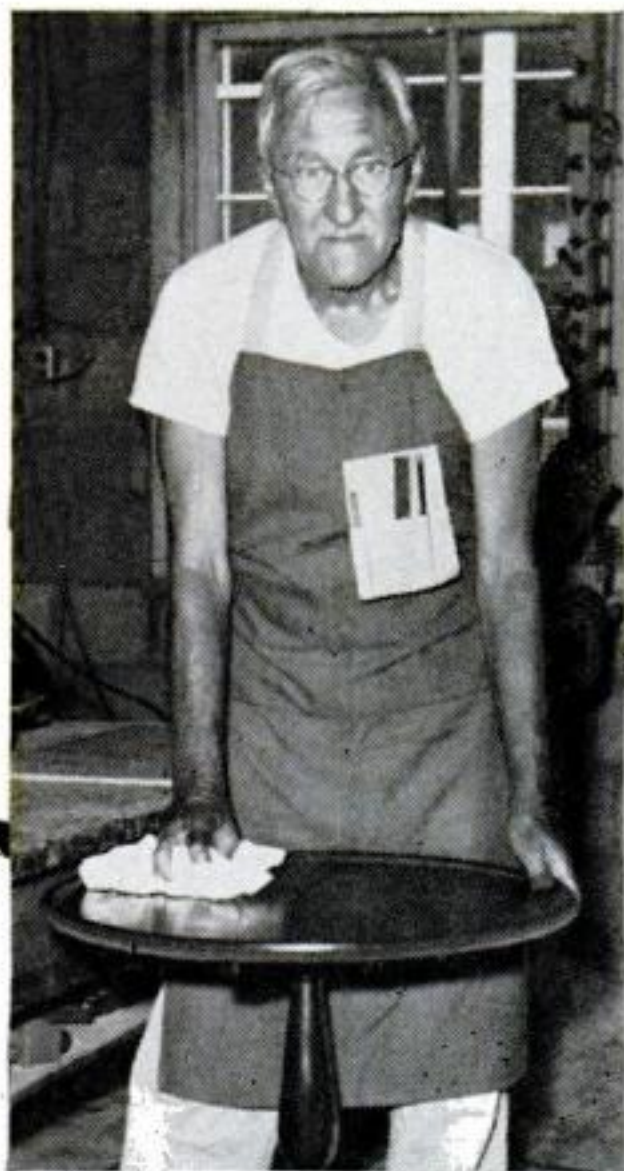
THIS APPLICATION will be equally useful at the kitchen sink or in the photo dark-room. Just hold a dish or batch of negatives under the faucet and the photo relay turns the water on for rinsing.

A light beam is aimed across the sink just under the faucet. A solenoid valve (Gould, Type M, 1/2" size, Nielson Hydraulic, Pelham, N. Y.) attached to the faucet opens when the beam is interrupted for washing.



Postscript to

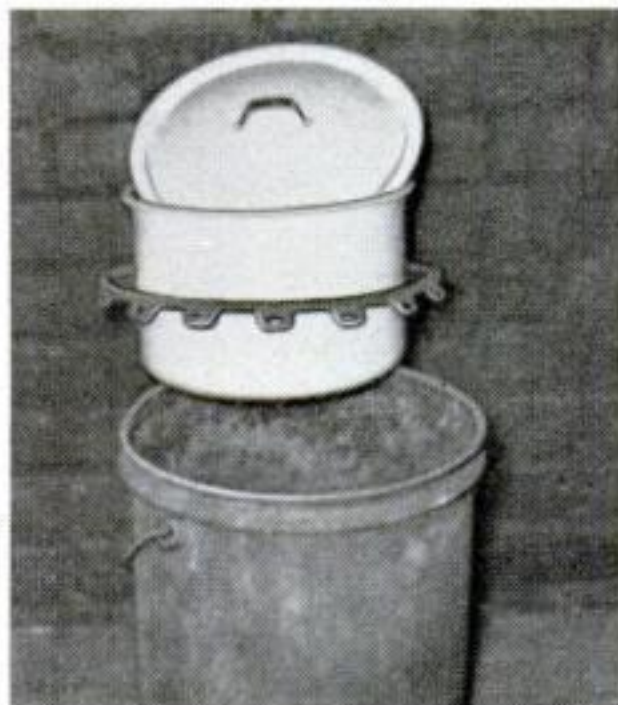
An Old-Timer's Formula for Fine Wood Finishing



OLD FAVORITE: The photo and title above introduced one of the most popular articles ever published by PS. Now, because of continuing demand for fuller data about two points, we give you this postscript.

The Editors

HOW THE AUTHOR DOES IT: R. C. Stanley, shown at work above, has used the outfit below for years to boil linseed oil—a three-gal. enamelware lidded pot fitting in lid of a five-gal. steel drum. Boiling the water in the drum heats the oil in the pot.



By R. C. Stanley

SINCE my article on Wonderlux Wood Finish appeared in POPULAR SCIENCE [Nov., 1959], I've learned that one of the main elements, boiled linseed oil, is no longer easily available. As a result, many persons have had trouble with the finish.

They have told me that the specified solution of clear spar varnish, boiled linseed oil, and turpentine leaves a gummy, sticky surface on the wood, no matter how much they rub. This is a clear indication that raw linseed oil, with driers added, has been used—and not boiled linseed.

Kettle-boiled linseed oil, also known as hard oil, has had the vegetable fats removed by boiling and is a much deeper color than raw oil. It used to be that kettle-boiled linseed was widely available. But what you get now as "boiled" linseed is usually just raw oil with driers added. The fats in it cause the sticky surface.

Boiling your own oil is the best answer. I've been doing it for years. It takes three to five hours, depending on the amount of oil you start with.

Place a quart or so of raw oil in a double boiler—more if a larger boiler is available. But don't fill the upper container too full. Keep the lid on and bring the water to a boil. Maintain maximum heat; keep the lid on and the water boiling. In about two hours the vegetable fat will begin to separate from the oil and rise to the top.

The floating fat first has a sickly white

color. It gradually darkens to an ivory color, indicating that all of the fat has separated and risen. The simplest way to remove fat is to siphon it off with a small rubber tube. Then pour off the boiled oil into its own container, one that you can seal. The residual oil in the double boiler is easily removed with hot water and soap if you act at once.

A **potash solution** is the basis of the Wonderlux finish. Concentrated lye has been suggested as a substitute, but this should never be used. Crude potash (the wood lye our grandmothers used in making soap) brings out the wood's natural colors. It does this without burning the wood. Concentrated lye will bring out colors but will not develop a patina.

Pearlash was recommended in the original article as a substitute for crude potash, but this is no longer available in small quantities. This should prove no drawback, however. There is no difficulty in getting wood ashes. A bushel of ashes, thoroughly percolated, will make about 2½ gallons of potash solution.*

The leaching setup you need is shown in a drawing on the following page. Put ashes in the hopper and pour on water to wet them thoroughly. Then add more water to do the leaching, or dripping. Pour the same water back over the ashes twice a day, morning and evening, adding a little water each time. Continue this for from three to five days.

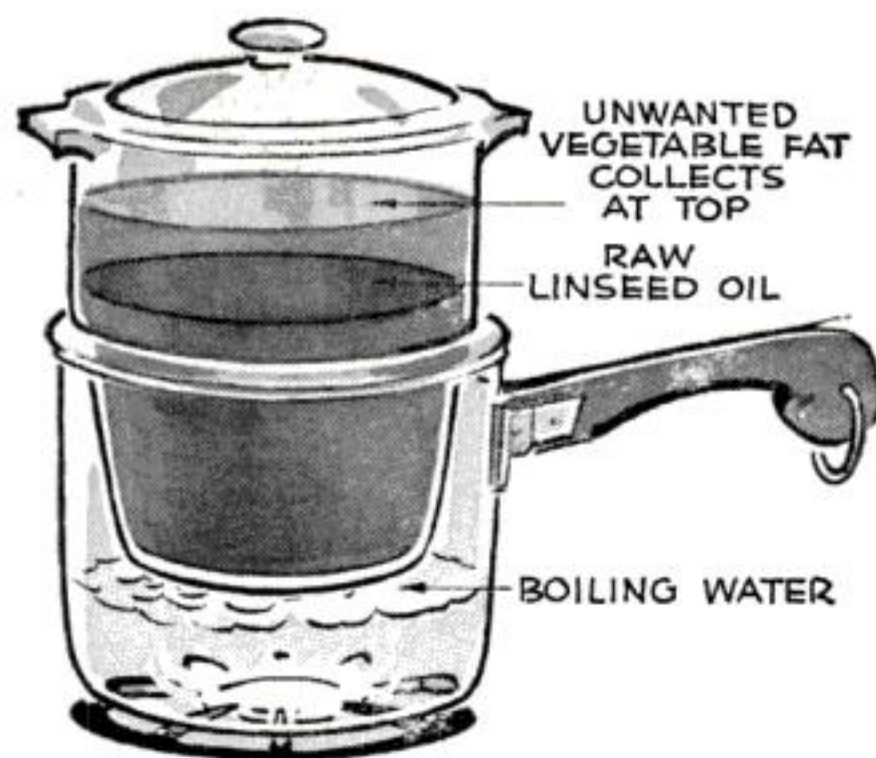
Turpentine is the cure for a sticky surface left through use of the synthetic boiled oil. Scrubbing with turpentine also removes wax.

[The text that follows is a condensation of Mr. Stanley's original article on his Wonderlux finish.]

OVER the years I have developed a natural finish that brings out, in depth, all of the beautiful natural colors and shades of color in any dry wood. The finish also creates, in the comparatively short time of 2 to 12 months, a patina that equals natural aging of 100 years or more.

All woods contain varying amounts of albumin. A natural patina comes from a film of albumin forming on the surface. It is believed that a photochemical action draws the albumin to the surface.

*Crude potash, a caustic liquid, is not mailable by parcel post and is expensive to send by express. Mr. Stanley does not sell either potash or wood ashes.



HOW YOU CAN BOIL LINSEED OIL: Use a double boiler on the kitchen stove to make a quart or so of boiled linseed oil. This is enough to keep you going for some time. Siphon off the white-colored vegetable fat that collects on the oil, using rubber tubing. Pour the remaining oil into its own container. The double boiler should be washed out at once.

The potash solution speeds up the process by combining with albumin and drawing it to the surface. It does this in days or weeks instead of years.

The patina forms more rapidly on most softwoods than on hardwoods. When the patina film has formed, chemists can find no difference between it and the film created by a century of use and exposure to light. Result: the same mellow coloring of wood grown beautiful with age.

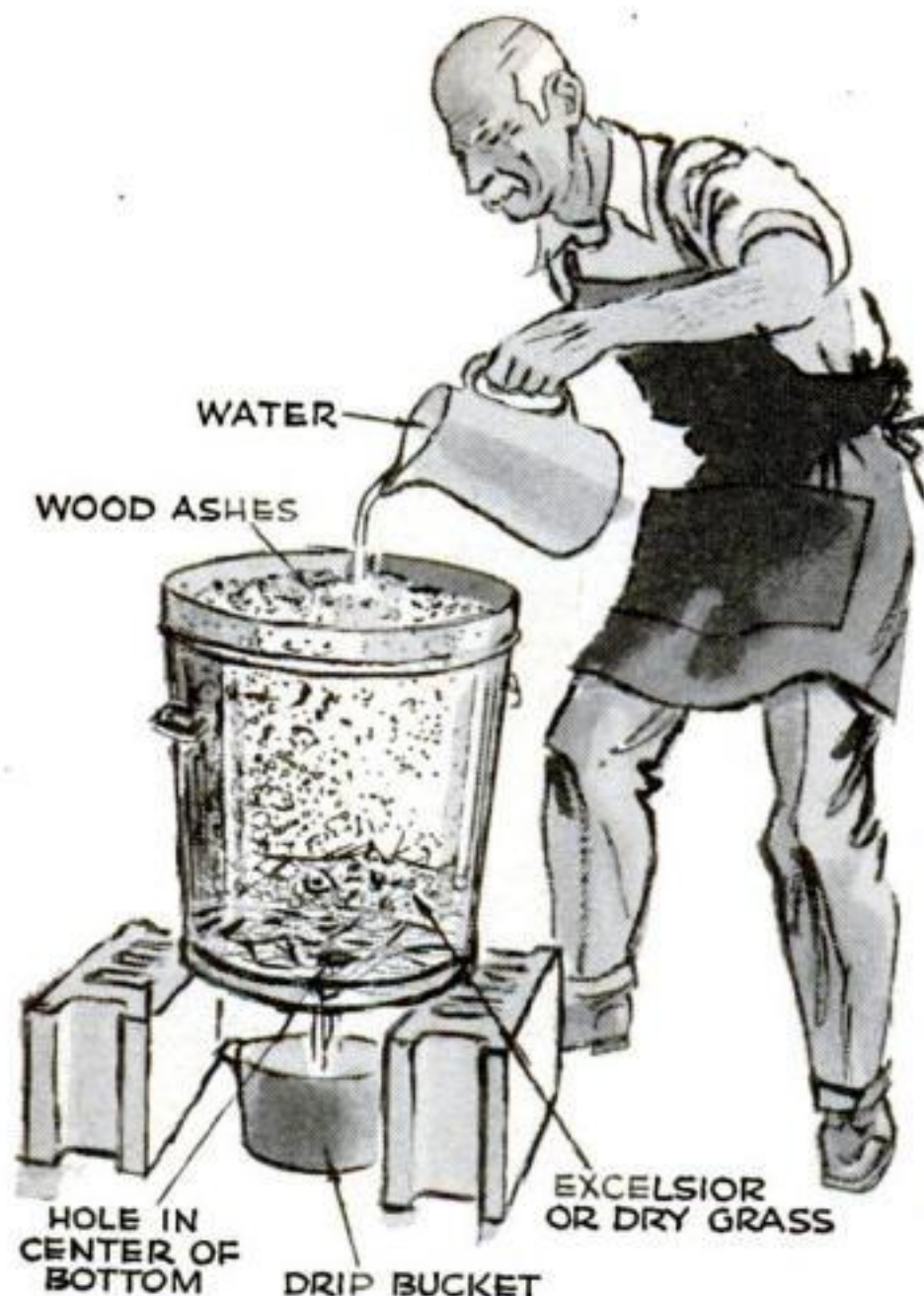
My Wonderlux is about the least expensive finish I know of, but it does require time and elbow grease, lots of it.

Any previous finish must be removed, preferably by scraping lightly. Parts that are difficult to scrape may be cleaned with varnish remover and a stiff bristle brush, followed by garnet paper or coarse steel wool, or both.

Wonderlux finish requires three separate operations with three materials.

Step 1. The first material to be applied to the wood is a mild solution of potash in water. Crude potash, obtained by leaching wood ashes, is preferred. For the hard, close-grained woods, the solution should be somewhat stronger than for soft, more porous wood. (Do not put the solution in a plastic or aluminum container.)

The potash solution may be applied with a paintbrush. I wear rubber gloves



HOW TO MAKE POTASH SOLUTION: Leaching wood ashes with a setup like this will give you all the potash solution you need for the wood-finishing formula. For the ash hopper and drip bucket, you can use any metal except aluminum. You can also use a wooden hopper and a glass drip bucket—but don't use plastic. Excelsior holds the ashes in the container.

(it discolours the fingernails otherwise) and rub the solution into the wood with a cotton rag. The aim is a uniform saturation of the wood surface with as much penetration as possible. The solution will cause only slight discoloration of the wood surface. Hardwoods should be given a second application after the first is thoroughly dry, and allowed to dry from 4 to 10 days.

Since wetting the wood surface will have raised the grain, you will need to remove the fuzz. Do this with very fine garnet finishing paper or fine steel wool. Wood treated only with the potash solution will show the greenish-yellow film of patina in a few weeks or months, depending on the wood. Frequent rubbing down with a dry cotton rag is an excellent substitute for use. An additional application of the solution after a few weeks will help, too.

Step 2. In from 2 to 10 days (depending on the hardness of the wood) after applying the potash solution, put on the first coat of the final finish. This consists of equal parts of a good grade of clear spar varnish, kettle-boiled linseed oil, and turpentine—preferably distilled spirits of turpentine. The turpentine is a thinner. If the mixture seems too heavy, add more.

Rub this mixture into the surface of the wood with a well-washed cotton rag free of lint, such as an old shirt; new cloth is not suitable because of lint.

Dip the cloth into the developing mixture, then squeeze it out until it doesn't drip. Rub the wood briskly with the saturated rag. Replenish the rag as needed.

When the mixture has been rubbed in thoroughly, squeeze the rubbing rag as dry as possible and rub down the surface until it looks dry. This application may be repeated in a few days if desired, after removing any excess varnish with fine steel wool. Always remove all excess varnish—that which was not rubbed into the wood—before applying wax, the final coat of the finish.

Step 3. For this, use good floor wax. But be sure the wood surface suits you, for nothing will follow wax. The first two or three waxings, several weeks apart, should be paste wax, rubbed in thoroughly. Thereafter liquid wax is good if preferred.

Note that I stress that all the finish is to be thoroughly rubbed into the wood. This is important. Any residual oil or varnish detracts from the finish.

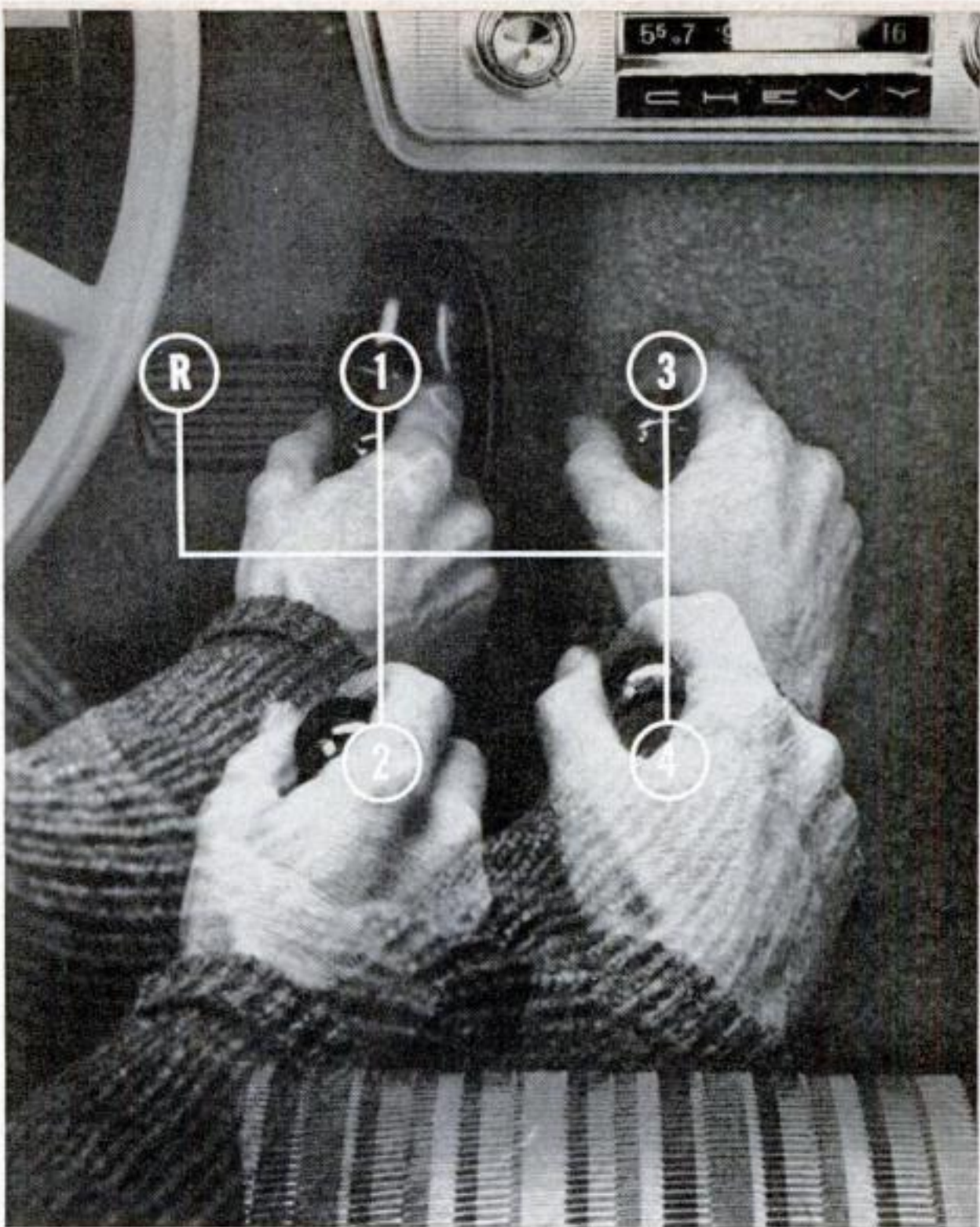
It often happens that two kinds of wood are used together, one much darker than the other. If desired, a small amount of dry powdered umber may be added to the potash solution for the light wood. Raw umber is yellowish brown. Burnt umber is reddish brown. Either of them will add color to light wood and will appear as natural color, not as stain.

Wonderlux wood finish improves with age on any interior woodwork—furniture, walls, floors, or whatever. The only attention it ever needs is a light waxing every year or so. Frequent rubbing down with a dry cotton rag improves it. Walls, furniture, and other woodwork I finished years ago are now more beautiful than ever.

'61 CHEVY CORVAIR: THREE TRANSMISSIONS

You know, one extremely pleasant thing about Corvair is its versatility. For instance, take transmissions. You can, of course, choose the standard three-speed box or Corvair Powerglide*.

But the big news (fanfare, please) is our new floor-mounted all synchro-mesh four-speed transmission*. Essentially, it's patterned after the design you'll find on many a Corvette—and the experts say that one's among the best in the business. For the technically minded, Corvair's four speeds line up like this: first, 3.65:1; second, 2.35:1; third, 1.44:1 and top 1.00:1. Nicely



spaced, superbly supple.

Now, maybe you figure a four-speed gearbox gives you just another gear to shift. But then maybe you've never dropped your hand onto a palmful of pure driving sport. Frankly, though, it's next to impossible to sell you on an outfit like this in words. You've got to sell yourself

—which you'll probably do, once you've had a taste of it. At your Chevrolet dealer's. . . . Chevrolet Division of General Motors, Detroit 2, Michigan. *Optional at extra cost.

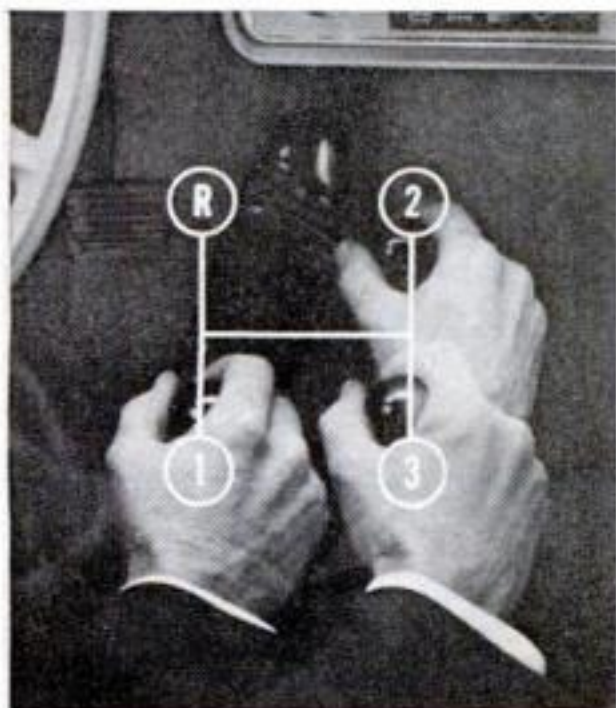


by Chevrolet

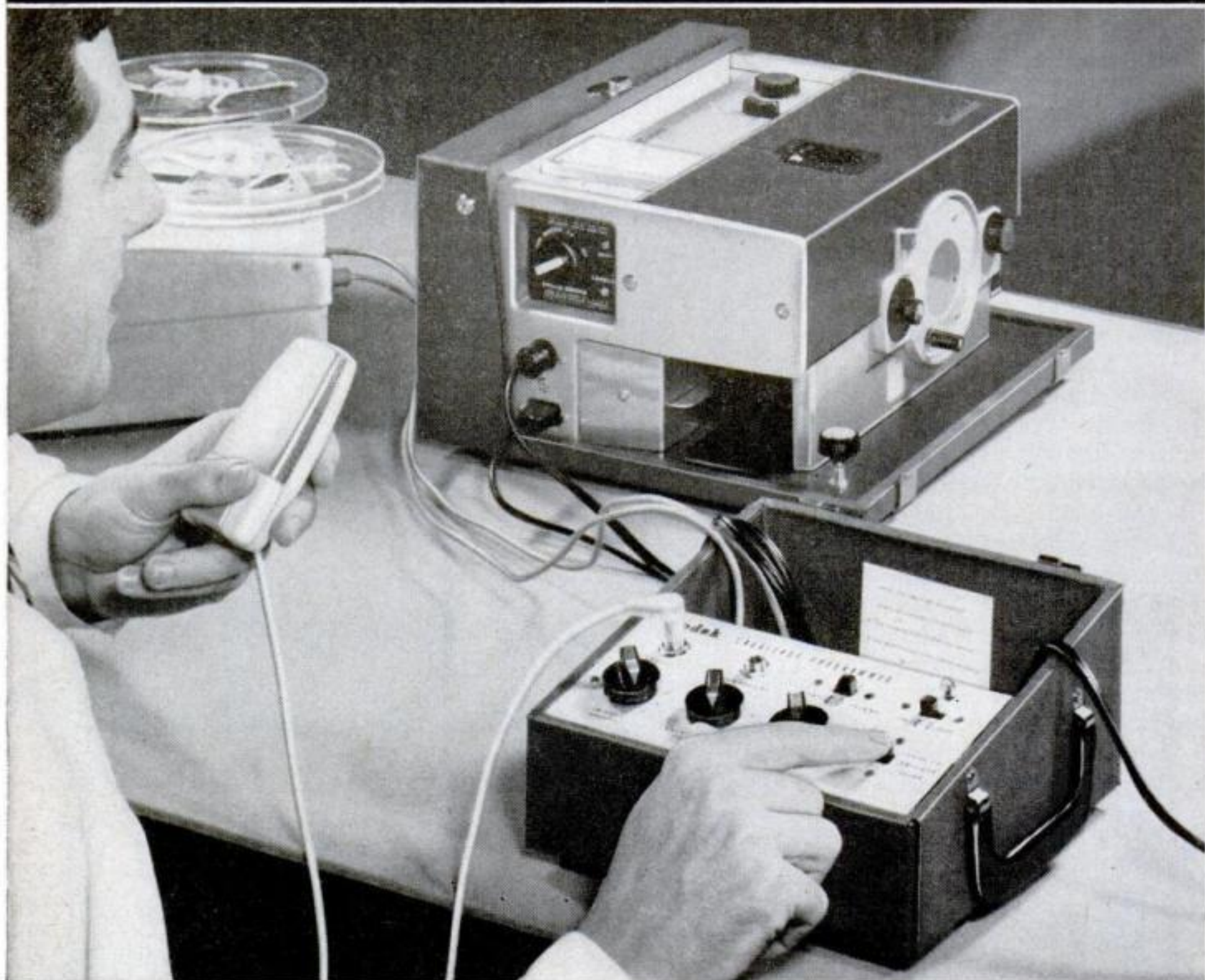


The lively Corvair 700 Club Coupe

Corvair, you know, is still the most advanced car in the land—and we've had a solid year to refine those engineering marvels: independent suspension all round . . . air-cooled aluminum engine in the rear and all the rest. Check into it—and while you're at your dealer's, get a load of that Greenbrier Sports Wagon!



New Ideas in Photography



How to make a slide show—with synchronized sound!

New Kodak Programmer lets you add voices, music, sound effects to any series of slides

An ingenious new unit by Kodak brings synchronized sound to slide presentations. The Kodak Cavalcade Programmer, Model 1, enables you to add taped music, comments or sound effects to go with any set of slides at do-it-yourself cost.

How it Works

You simply connect the Programmer to a tape recorder and any Kodak Cavalcade Projector. Speak into the microphone. After your narration for each slide, press a button on the Programmer.

This puts a "tripper signal" on the tape.

In playback, the same hookup is used. Your taped narration comes through just as you recorded it, and the taped signals cause each slide to change at the correct moment.

Continuous Showings Possible

With the special Kodak Cavalcade Repeating Projector, and a repeater-type tape recorder, continuous shows can be programmed. The show will repeat until you turn the equipment off.

Price of the Kodak Cavalcade Programmer is less than \$96. Kodak Cavalcade Projectors are priced from less than \$110. See your Kodak dealer for exact retail prices.

from Kodak

Vacuum Coating Helps Tiny Reflectors Put More Light on the Subject

A tissue-thin layer of aluminum—*only two molecules thick*—gives the small, built-in reflector on this Brownie Starmite Camera (see photo at right) its bright, mirror-like finish.

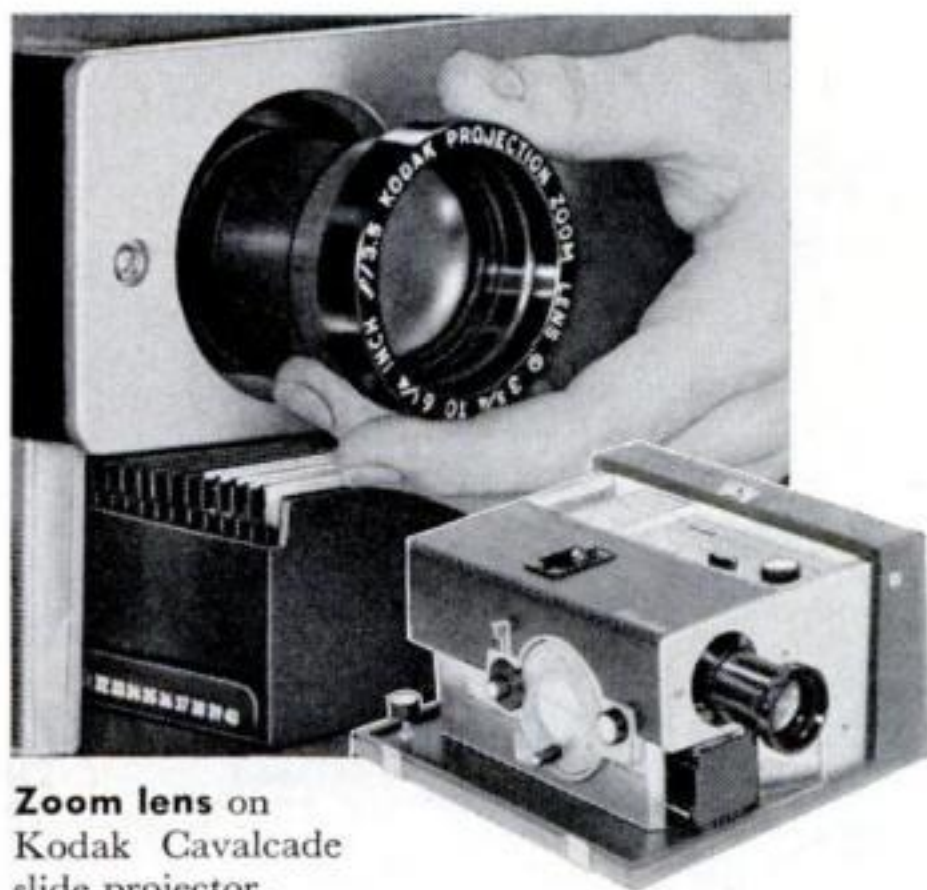
Vaporized aluminum is deposited on the reflectors as they turn on racks inside big vacuum ovens.

The result: reflectors for Brownie Starmite and Starflash Cameras provide more reflected light than many units twice their size. An invisible lacquer coating prevents fingerprints from injuring the sparkling mirror-bright surface.

These pint-size reflectors from Kodak pay off in smaller cameras and clearer pictures for you.



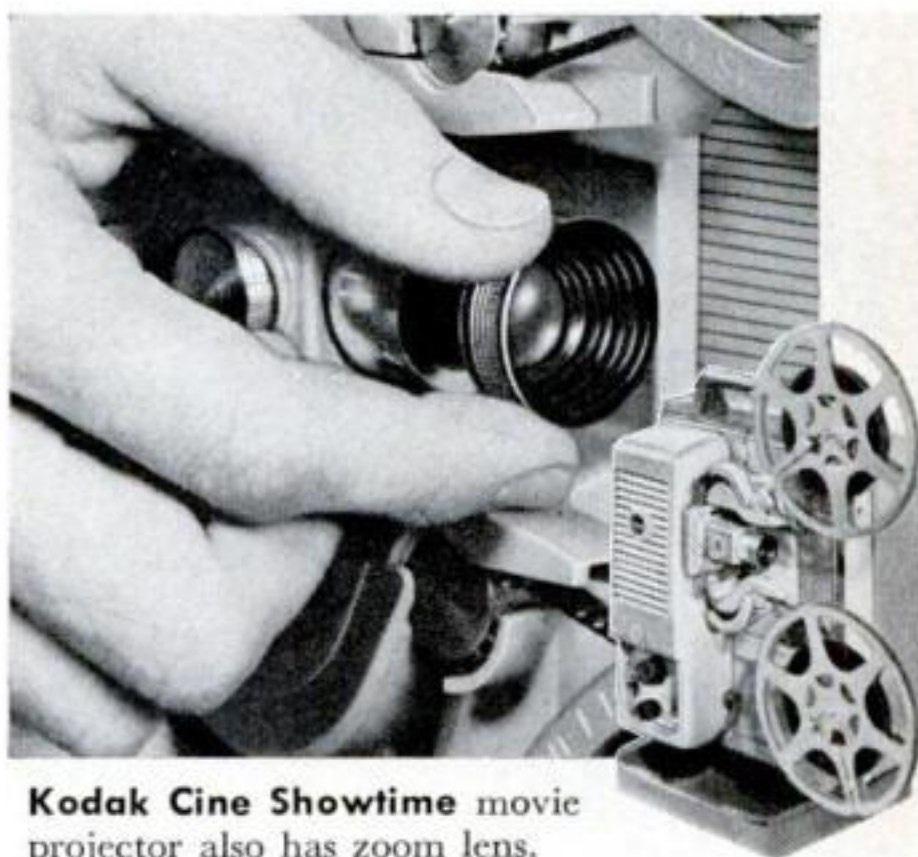
Only 2 inches in diameter, the reflector on this Brownie Starmite Camera has a Lumiclad "mirror finish" that enables it to reflect and direct more light than some units twice as large.



Zoom lens on Kodak Cavalcade slide projector.

New Zoom Projection "Shrinks" or "Stretches" Your Living Room

Zoom projection is here—and it can "shorten" or "stretch" your living room when you're showing slides or movies. Just set up your projector at the most convenient point—for a few guests or a



Kodak Cine Showtime movie projector also has zoom lens.

large party. Then slide the lens back or forward, to make image exactly fill your screen.

Zoom lenses can also be used to "zoom up" picture areas of special interest when showing slides. These lenses can be purchased separately—or as standard equipment on new Kodak Cavalcade and Showtime Projectors.

Prices are subject to change without notice.

Picture it now — enjoy it again and again

EASTMAN KODAK COMPANY, Rochester 4, N.Y.

See Kodak's "The Ed Sullivan Show" and "The Adventures of Ozzie and Harriet"

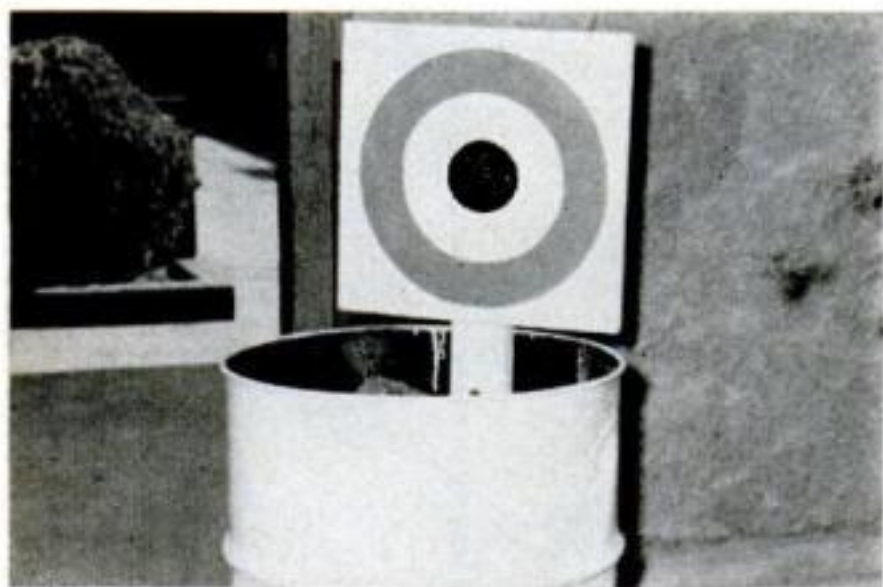
Kodak
TRADEMARK

Short Cuts and Tips

FROM PS READERS

Clean-Up Basin from Salvaged Sink

SOLVENT for cleaning shop parts should be handled with care. You can make a safe drain-off basin from a discarded sink by suspending it in a wood or metal frame built to fit its flange. A drain cock on a short section of pipe lets you fill and empty the sink; drums placed underneath catch solvent for re-use. An attached screen keeps spatter off the walls.—*Phil McCafferty, Cedar Rapids, Ia.*



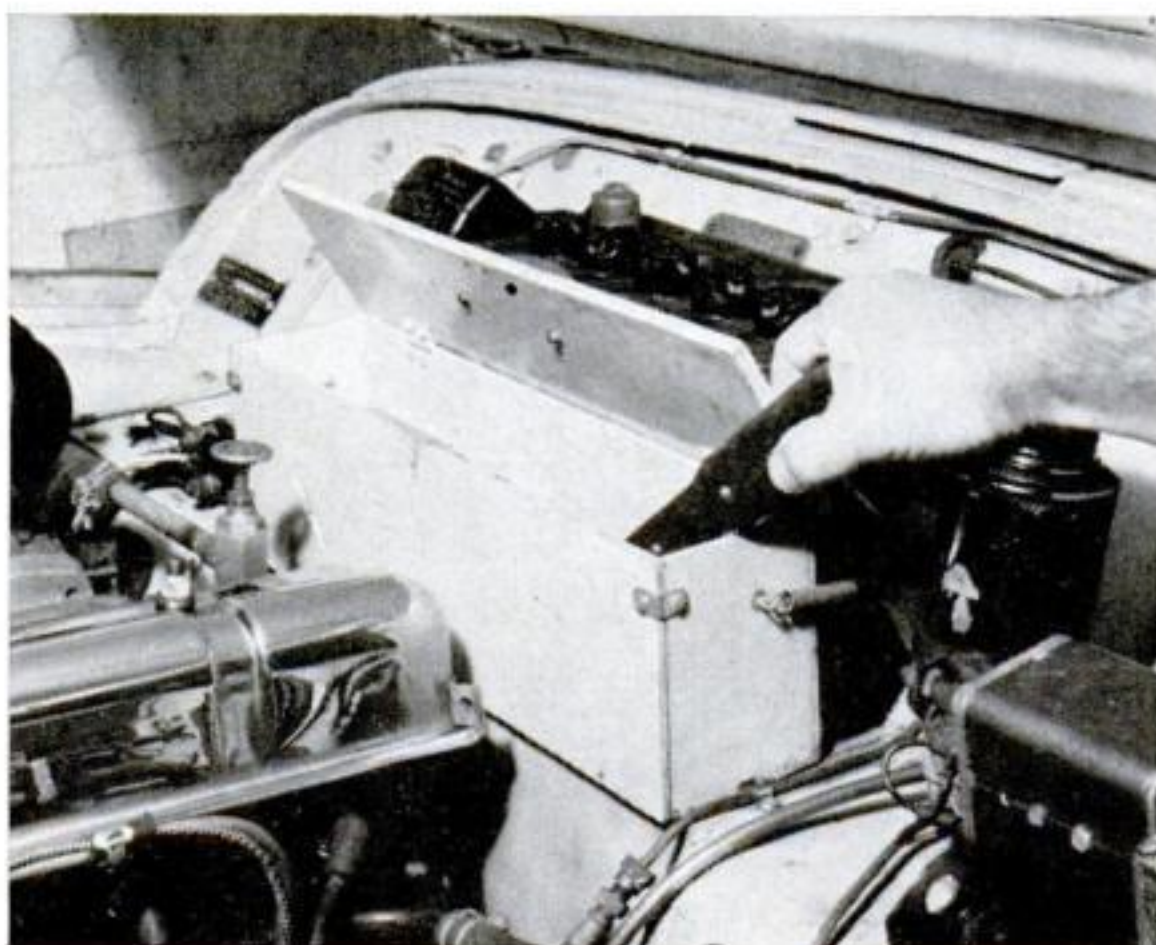
Target Improves Trash-Can Aim

IRKED by the litter students left around a trash can, the principal of a California elementary school added this target to encourage more accurate aim. It works.—*Hi Sibley, Nuevo, Calif.*

▶▶▶ No STAPLING gun available for an emergency heavy-duty repair? A light stapler may do the job if you tap it sharply with a small rubber mallet instead of your hand.—*T. A. Flynn, NYC.*

Auto Tool Chest Stored Under Hood

THE logical place for automobile tools is where they're used most—up front in the engine compartment. A box of plywood or hardboard, sized to fit an open area, need only be large enough to hold a couple of wrenches, pliers, screwdrivers, spare fuses and plugs, stuffed down with a wiping rag. Some engines wobble at idling speed, so allow clearance if you plan to mount the box close to the block.—*Robert Hertzberg, Douglaston, N. Y.*



Tips from Weldwood—the people who know what's good for wood



**Kill termites, prevent rot with
WELDWOOD WOOD PRESERVATIVE . . .**



**Add lasting color to outdoor wood with
WELDWOOD EXTERIOR STAINS . . .**



**Seal and prime outdoor wood with
WELDWOOD FIRZITE . . .**



**Protect and beautify outdoor wood with
WELDWOOD SPAR VARNISH . . .**

WELDWOOD® WOOD PRESERVATIVE, essential where wood is in contact with earth, contains full 5% pentachlorophenol.

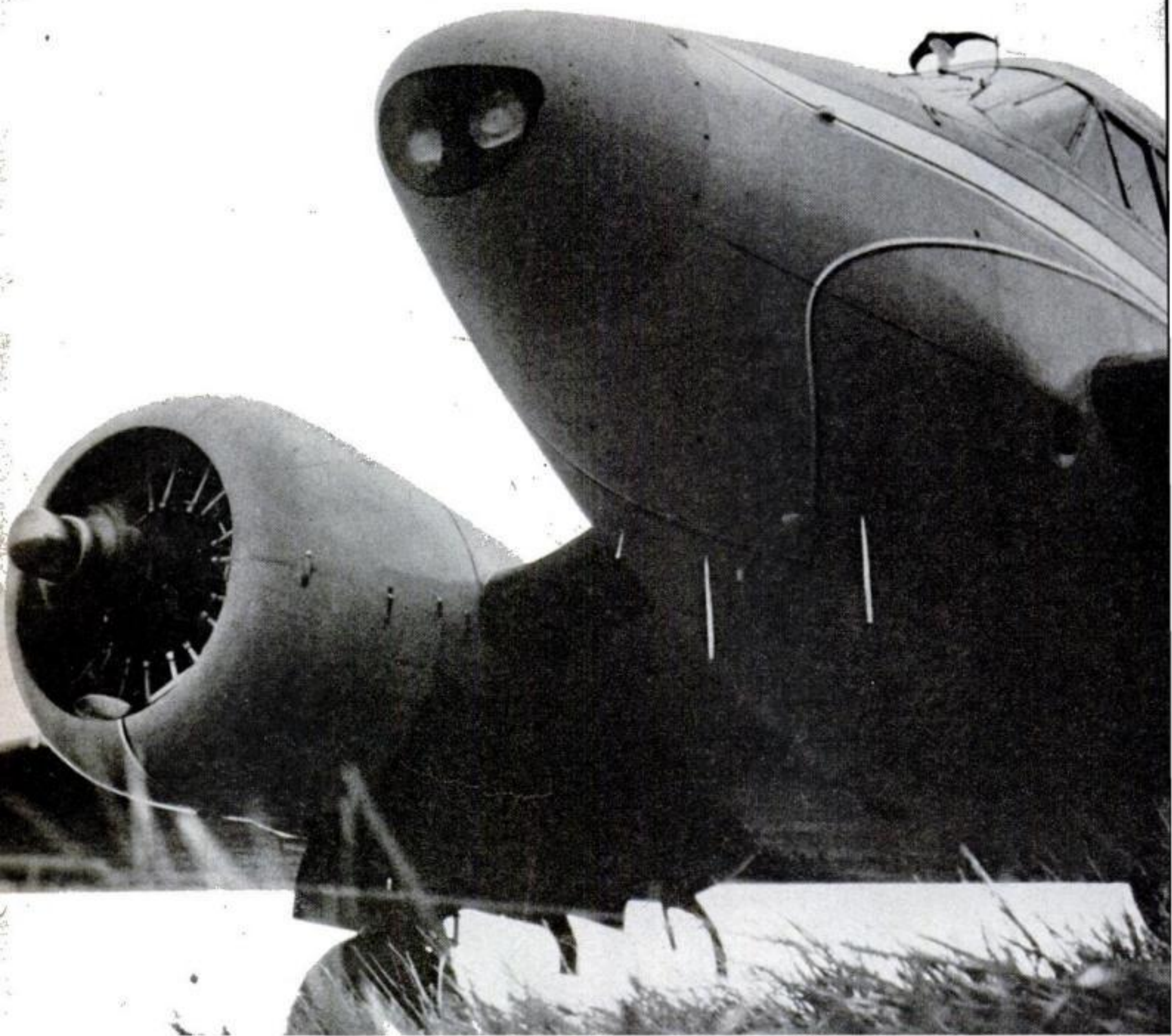
WELDWOOD EXTERIOR STAINS, 4 beautiful "woody" colors: Redwood, Driftwood, Cascade Green, Sierra Brown.

WELDWOOD FIRZITE®, a penetrating resin-sealer for fir plywood, pine, etc. Comes in *Clear* to prevent "wild grain" in stain jobs; and in *White*, a pigmented prime coat to combat checking in paint jobs.

WELDWOOD SPAR VARNISH, durable, high gloss exterior clear finish that resists discoloring even in severe weather.



Products of United States Plywood



The Beechcraft Super 18, one of the most reliable and popular planes ever built

Spark your car with Champions— the plugs that power more aircraft the world over!



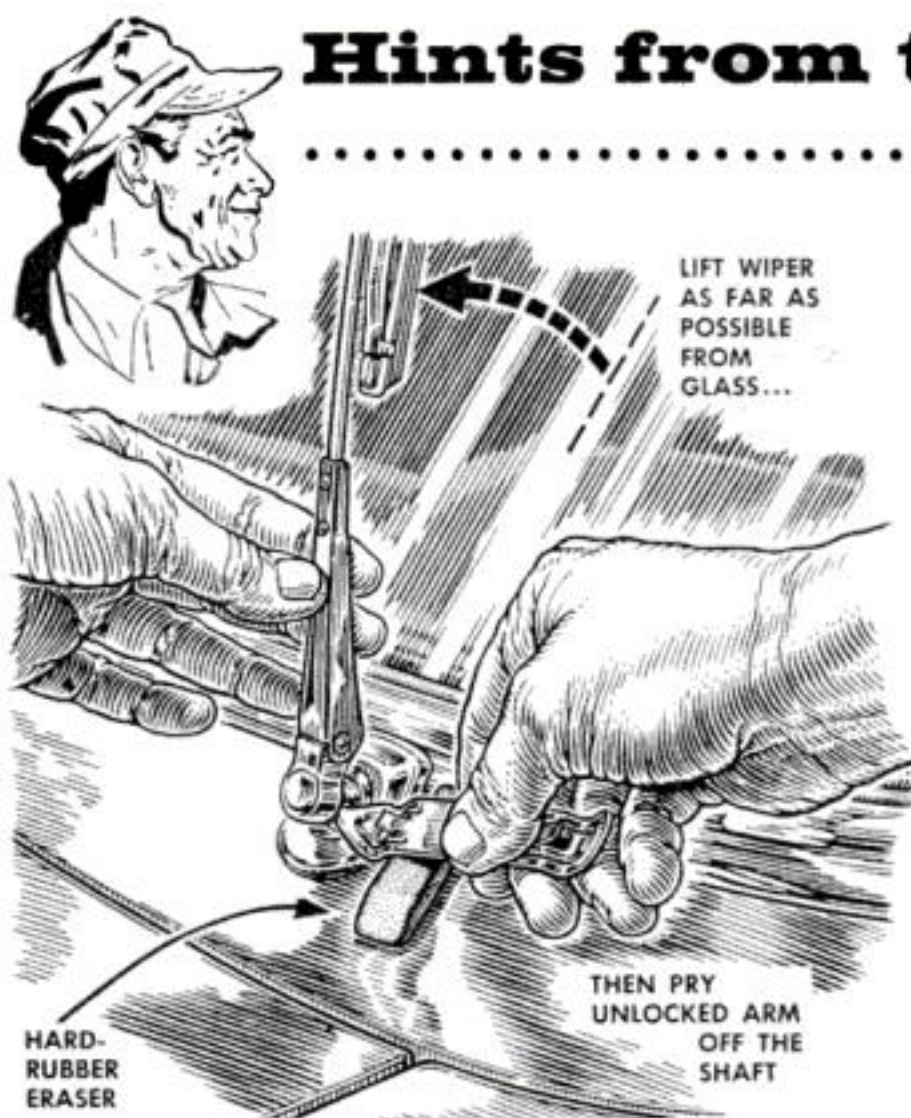
Twice as many car makers specify Champions for dependability. Above: Rambler American.

Airplanes can't risk misfiring spark plugs on take-off—or in the air. That's why dependable Champions are an overwhelming first choice with airlines and pilots. And *you* can't afford misfiring plugs when passing in today's parkway traffic. Put a new set of Champions in your car every 10,000 miles. They'll deliver greater dependability, safer passing power . . . and save money on gasoline!



CHAMPION

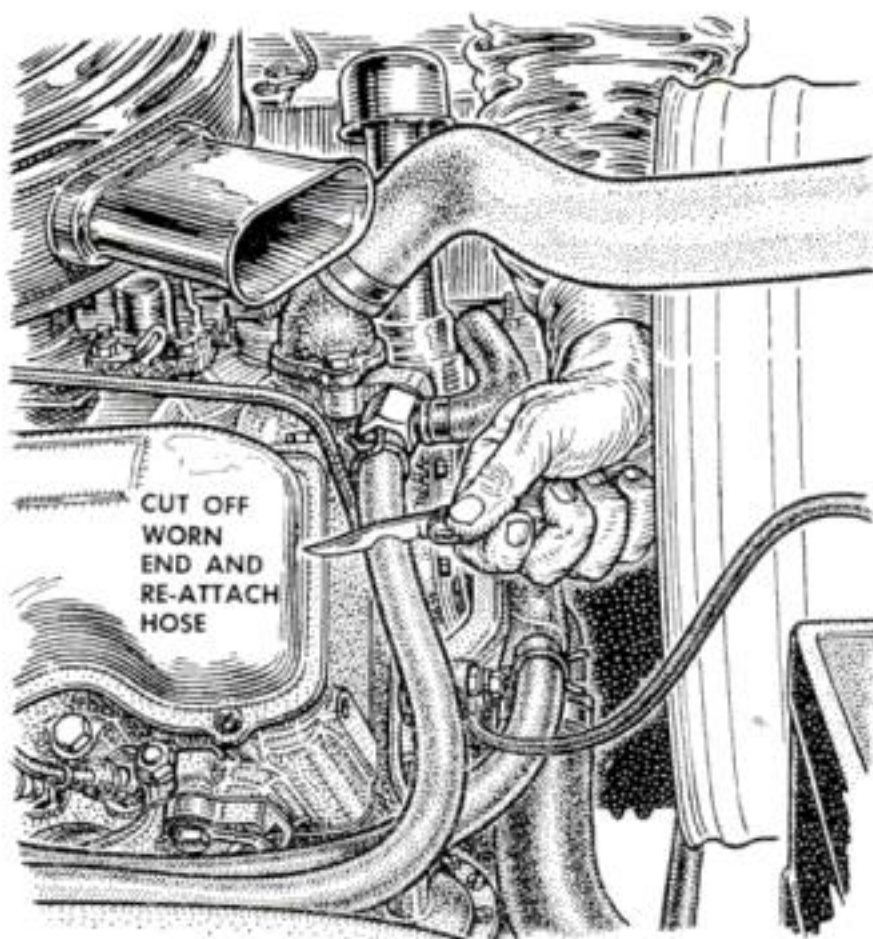
Hints from the Model Garage



Remove a stuck wiper arm this way and you won't mar surrounding paint. Rest a beer-can opener on a hard-rubber eraser to give you a padded fulcrum and hook the point under the hub. The wiper arm can then be pried off easily.



A dash-mounted handle makes it easier for front-seat passengers to get in and out. Use a screen-door handle and fasten it with sheet-metal screws. It will also provide a steadying handhold for children who like to ride standing up.



When installing a heater, leave some slack in the hose line. When the hose deteriorates at the engine—as it usually does first—you can cut off the bad end and reconnect the hose without installing a new line or draining the coolant.



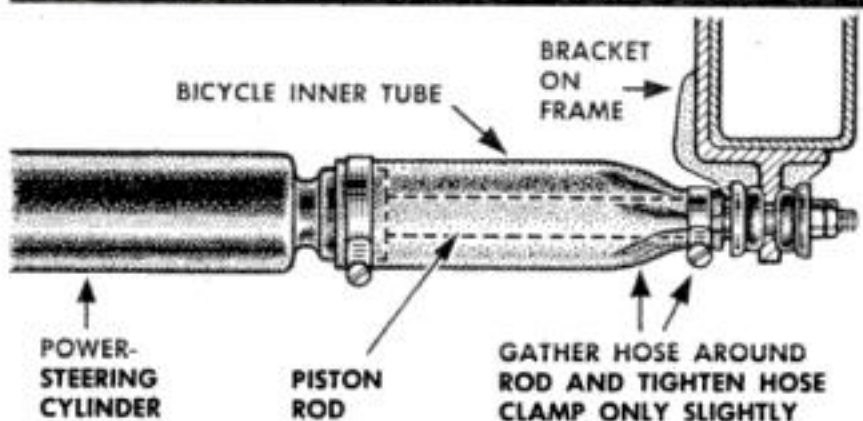
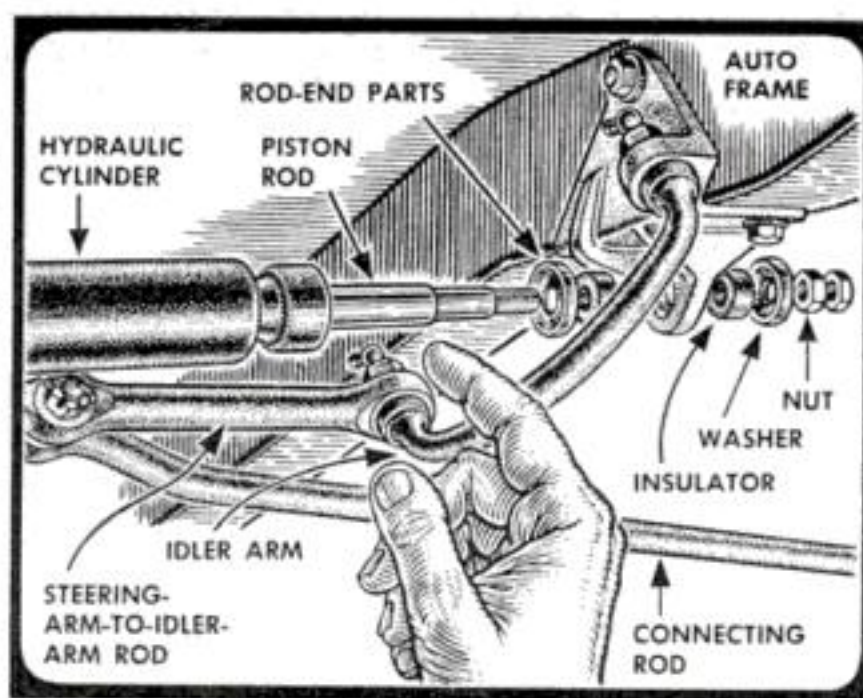
An emergency funnel for pouring gasoline from a can into a hard-to-reach filler pipe can be improvised from your car's flashlight. Remove both ends and the batteries, and insert the empty case into the filler pipe to extend it.

CONTINUED

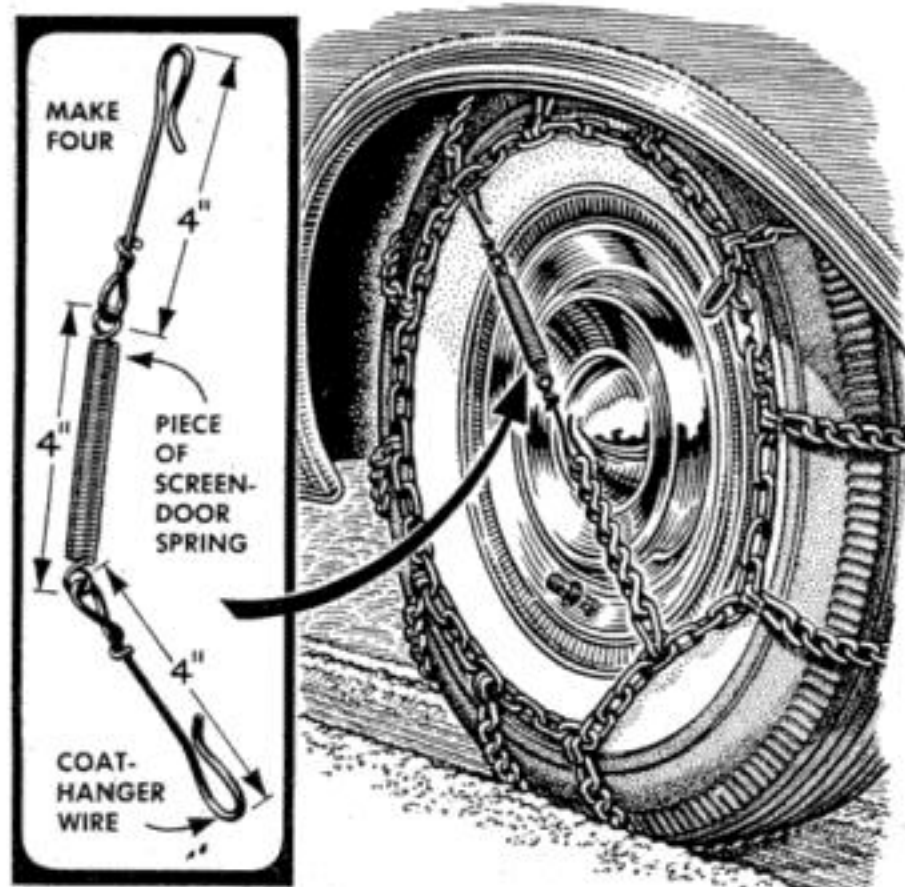
More Hints from the Model Garage



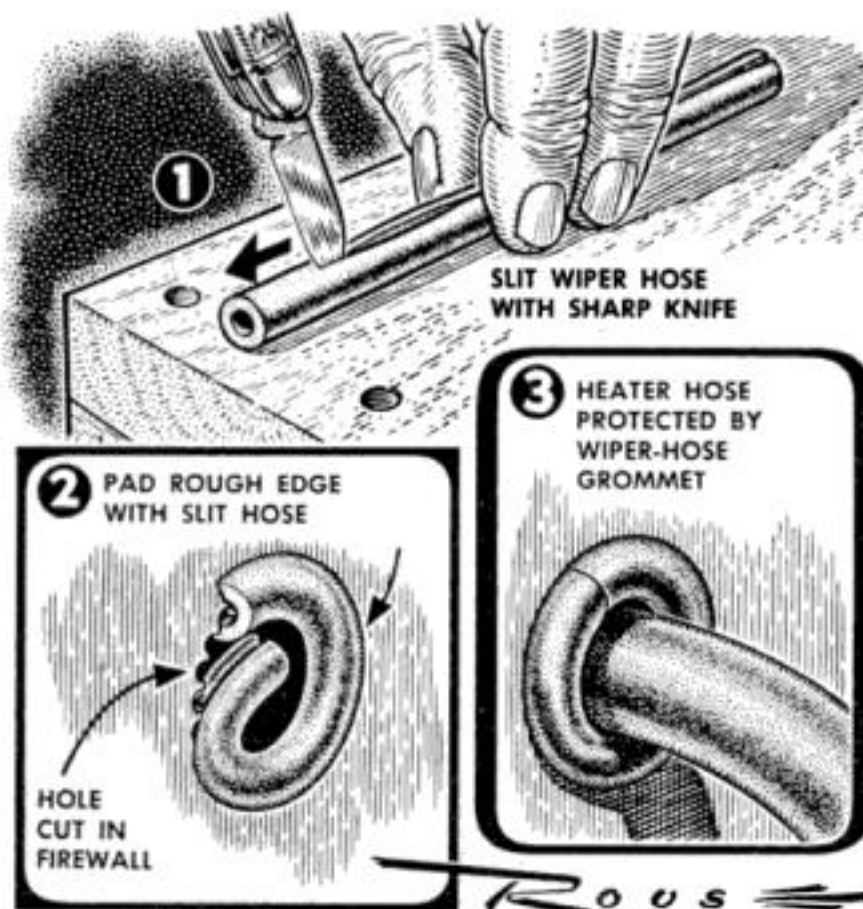
You can hush rattles in a spare-tire cover with this trick. Cut a slit around the inside diameter of an old bicycle inner tube and slip the tube over the rim of the cover. The cover will still fit its opening—but snugly and quietly.



Exposed power-steering pistons, found on some cars, pick up dirt and grit that ruin the hydraulic seal. You can stop this by covering the pistons with sleeves cut from a bicycle inner tube. Fasten the sleeves on with hose clamps.



Stop broken chains from clanking by carrying along a few of these spring clips. Cut 4" lengths from a screen-door spring and bend hooks from coat-hanger wire. They're faster to use than repair links and they hold the chains under tension.



A heater hose won't fray where it passes through the firewall if you make a grommet like this. Slit a length of rubber windshield-wiper hose down the middle and slip the hose over the rough edges of the drilled-out hole in the firewall.

**"bargain"
batteries?**

OH YEAH!



Why try to get by with a "bargain" battery. Save time, money and trouble with a dependable Delco DC-12 Dry Charge! You can figure this one out fast. What does it cost you to be late for work? A couple of hours missed because of a bad battery adds up to inconvenience . . . and money. You'll avoid such trouble with a sure-starting Delco Dry Charge Battery.

ALL THE POWER YOU PAY FOR . . . DELCO!
A Delco DC-12 stays bone dry . . . can't lose any "zing" on the shelf! When you buy it, the dealer adds the fluid that activates it with 100% fresh starting power . . . plus the reserve power required for modern automotive electrical equipment.

YOUR BEST QUALITY BUY . . . DELCO DC-12!
Extra fluid capacity—Less refilling, less danger of damage from low fluid level. *Hard rubber case*—Stronger, also resists heat distortion. *Microporous rubber separators*—More current flows between plates, means peak power at all temperatures. Ask your dealer about these and many other Delco quality features.

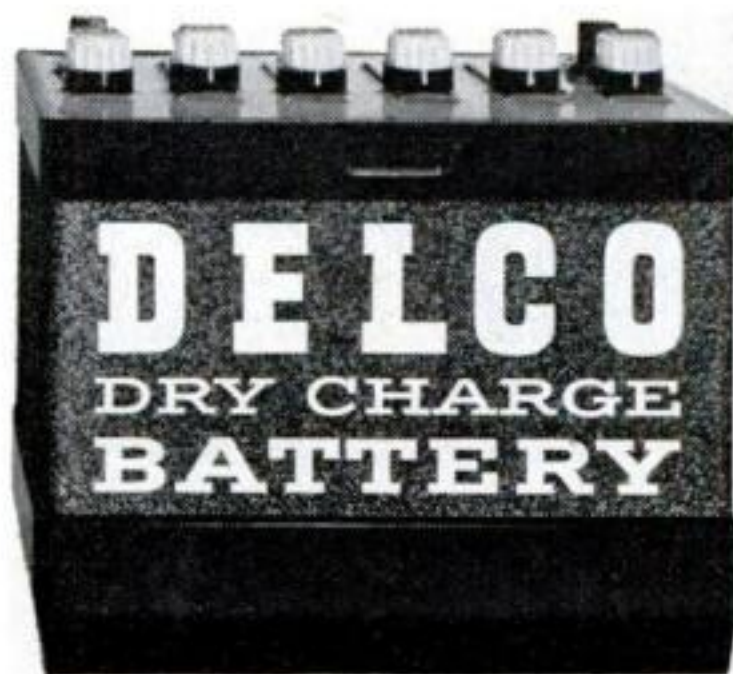
A DEALER NEAR YOU . . . DELCO!

He's a *local* businessman who appreciates your service business, wants to keep it. Automotive service is not just a sideline with him . . . it's his

specialty! He knows your driving needs, can recommend the right Delco Battery for your car.

BE SURE . . . REPLACE WITH DELCO!

For dependable starting in any weather, replace with 100% fresh Delco. It's "Designers' Choice" for most new cars, survey-proved as "Drivers' Choice" for replacement, too. When it's time to replace your old battery, make sure you get a Delco DC-12! *DELCO ENTERTAINS YOU*—"Stagecoach West" and "The Islanders"—ABC-TV.



DELCO . . . "A GOOD NAME FOR GOOD SERVICE!"

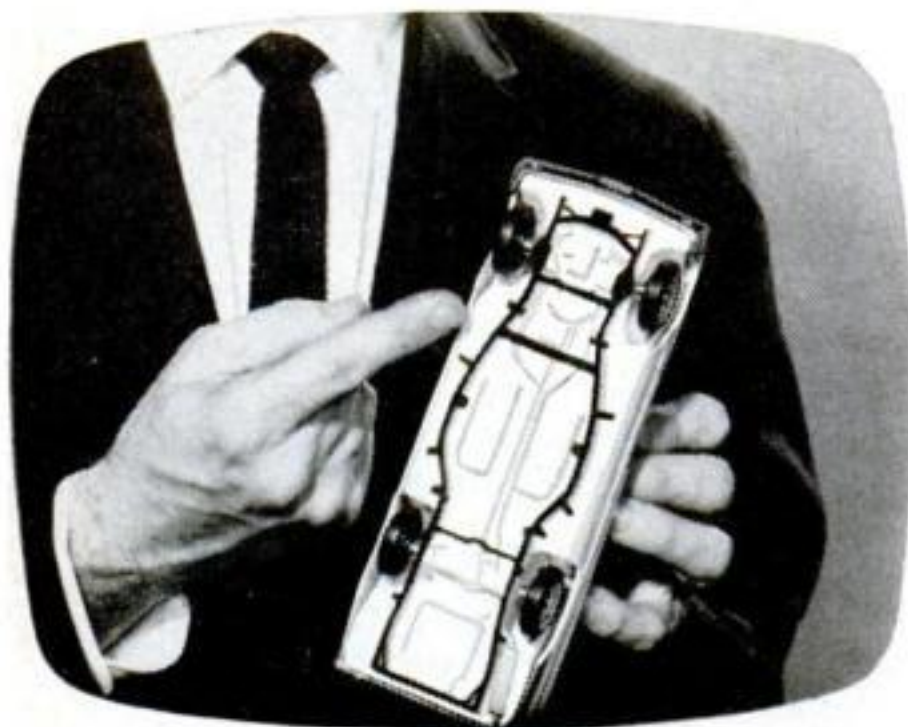
Another reliable
General Motors product,
distributed nationally through



The 1961 Ford



Professor Jonathan Karas, physicist at Lowell Technological Institute, uses an X-ray to demonstrate—as he does on Ford's TV shows—a remarkable feature of the '61 Ford.

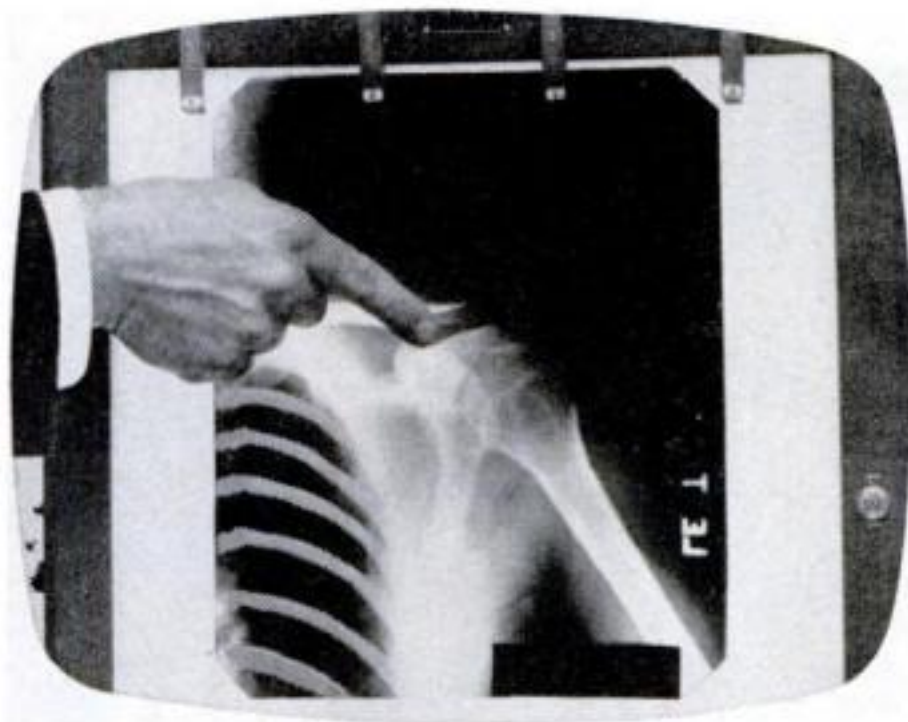


"Other cars require a chassis lubrication every one to two thousand miles costing up to \$45 in 30,000 miles. But Ford's famous ball-joint has a special sealed-in lubrication, very much like the human shoulder joint."



"Here it is, the crucial part of Ford's suspension. This unit is a ball-joint, protected by molybdenum disulfide grease, a new lubricant that Ford helped develop. It forms a molecular bond with the metal."

is built to go 30,000 miles between chassis lubrications



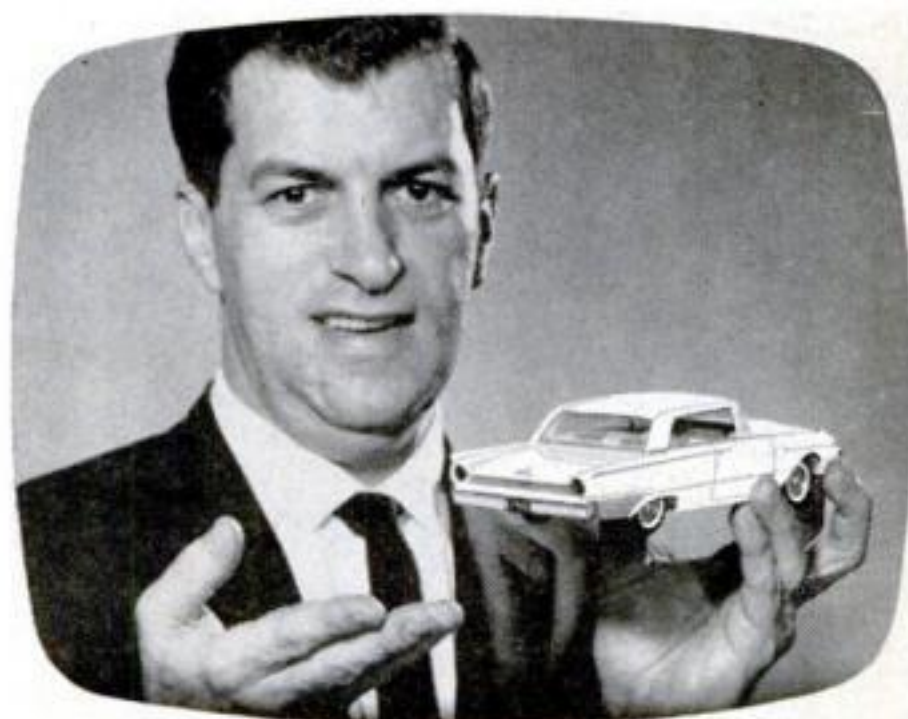
"This is a human shoulder joint. The reason it works so well and so dependably is that nature provides what is, in effect, a sealed-in lifetime lubrication."



"And this is a photograph of a ball-joint on the '61 Ford. Let me show you how Ford engineers took a tip from nature to give you more carefree driving."



"And this polyurethane ring, another Ford development, seals in the grease so well that Ford can go 30,000 miles between chassis lubrications. And these cost only about \$4—take about 20 minutes."



"Sealed-in lubrication is just one feature that makes the '61 Ford *beautifully built to take care of itself*. Two others are: self-adjusting brakes, and Full-Flow oil filtration . . . you change oil only every 4,000 miles."

FORD DIVISION, *Ford Motor Company*,

Gus Meets with Resistance

By Martin Bunn





"Now look, Mr. Wilson," Calladay said. "We don't want any trouble. You ever hear of voltage drop?"

"GUS WILSON?" asked the short, sunburned man who walked into the Model Garage.

"You've found him," said Gus.

The man unbuttoned his topcoat and whipped out a card.

"Nat Calladay, service manager of Plymouth Pumps."

"Oh, sure," said Gus. "You're here about that defective compressor."

"I'm here to investigate your complaint," said Calladay quickly.

The implication that it was unjustified made Gus bridle a bit. "I bought that new compressor from Ed Swain. Thought he'd come around about it."

"Swain's been transferred to a warmer climate for his health."

"I see," said Gus, recalling Swain's struggle with arthritis. "Well, this machine keeps opening the circuit breaker."

He led the way to one side of the shop, and a shiny new compressor.

"Only way we can get air now is to hold in the breaker. Listen to it."

He threw up the switch handle. The big motor groaned into action, but died as a loud snap sounded across the shop.

"There goes the breaker," said Gus. "That motor's badly overloaded. Could be a tight bearing or a broken ring."

"Or could be," replied Calladay, "old-fashioned, inadequate wiring."

Gus shook his head. "Swain checked it, said it was okay for this model."

"Maybe he was a bit old-fashioned himself," suggested Calladay. "I'll send you a good electrician."

"Don't need one," said Gus flatly. "Either send your mechanics to check this machine or get it out of here."

"Now look, Mr. Wilson, we don't want any trouble. You ever hear of voltage drop?"

"Seems to me I have," said Gus.

"Well, now, this rig is about 60 feet from your service panel. You've got 120 volts there, but you deduct 60 and what've you got left?"

"Sixty?" asked Gus innocently.

"Sure. And what does the nameplate on that machine say? A hundred twenty. How d'you expect to run it on 60?"

Amused by this distortion of logic, Gus said nothing.

"So what's to be done?" went on Calladay glibly. "You get heavier wiring installed, and I'll guarantee . . ."

"Your company's guarantee is what I count on," said Gus. "If you won't back it up, I'll go to them."

"I'll have to report your wiring's at fault. No hard feelings, I hope."

A LATE chill fell with dusk. Stan Hicks, Gus's assistant, had locked the pumps and shut the shop, but Gus remained for some paperwork. He was surprised by a hammering on the shop door. It was Calladay.

"Say, am I glad you're in! Seems every other garage in this hick town is buttoned up for the night."

"We're closed, too."

"My car's stuck in the municipal parking lot. The battery won't turn the engine."

"Plenty of service stations open."

"Yeah, but they say they have nobody to send out. Fact is, I had some arguments around here."

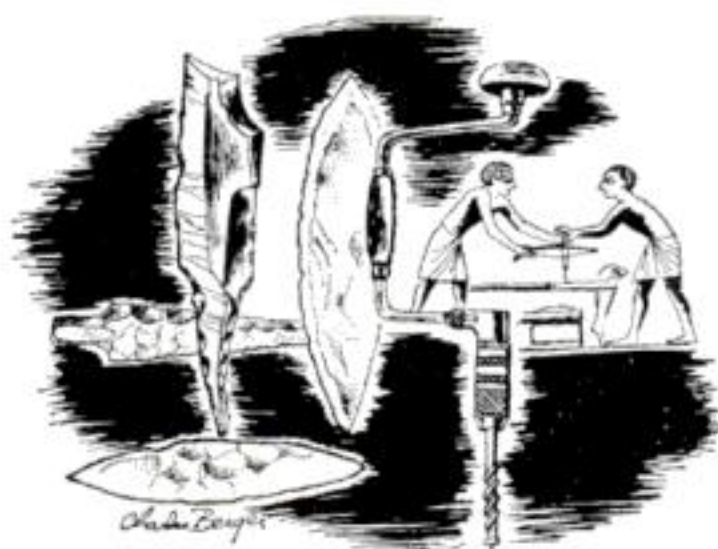
"Don't think I can help," said Gus.

"This cold snap's kept our charger so tied up on customers' cars that both our booster batteries are down."

"Couldn't you give me a push start? That lot closes at midnight. And if I don't get my car out tonight, the cops will give me a ticket."

A flicker of sympathy stirred in Gus. "Guess I've worked late enough. Wait a minute and we'll drive over."

Where'd it come from?



DRILL: Stone Age man could make a hole in soft wood or leather with flint points. Copper cultures used metal awls and points. The bow drill came into use toward the end of the third millennium B.C. (Rotary action was produced by looping a slack bow string around the drill and then drawing the bow back and forth.) The prototype of today's cutting-edged tool had to await the Iron Age to be perfected. Among the tools found at Thebes in Upper Egypt is a drill designed in modern style so that both edges cut forward when rotated.

BITTER cold assailed Gus as they left the garage. The city parking lot was almost empty. Under its stark floodlights stood a modest seven-year-old sedan.

Gus checked the battery terminals first. Both were tight. But the starter gave up the instant its pinion meshed.

"Let it roll back. I'll push with my truck."

The sedan slid back out of the slightly upgrade parking lot. Gus shoved it less than a hundred feet before the engine caught. Calladay scrambled out.

"How about leaving it in your shop?" the little man asked. "And could you in-

stall a new starter tomorrow?"

"Are you sure you need one?"

"I'm sure now. Besides, it won't start if I leave it out all night."

"Okay," agreed Gus. "Follow me."

IT WAS midday when Calladay reappeared.

"On thinking it over," he told Gus, "I guess we better tear down that compressor. Our mechanics are on the way."

"Fine," returned Gus. "I've been boosting your battery. What makes you think your starter's bad?"

"It began on my way up from Florida," said Calladay. "Fellow in North Carolina

AC's
superior sealing
qualities



positively protect against combustion gas leakage
and engine-damaging pre-ignition

With AC Spark Plugs you get superior gas sealing features that assure longer peak spark plug performance, maximum engine efficiency and economy.

First of all, there is AC's exclusive copper-glass conducting seal that fuses the terminal screw and center electrode to the insulator in a gas-tight bond. Then there is AC's famous shell shrinking process that tightly compresses gaskets placed between the upper and lower shoulders of the insulator to pre-

vent gas leakage between insulator and shell. Combustion gas leakage causes spark plugs to overheat, resulting in rapid electrode wear, engine-damaging pre-ignition and eventual spark plug destruction. AC Fire-Ring Spark Plugs give you full protection against these dangers—do a better job than ordinary spark plugs using cements or compacted powder seals. Next time your car needs a spark plug change, get top performance and smooth, long-lasting power by getting a new set of ACs.

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Fire-Ring spark plugs

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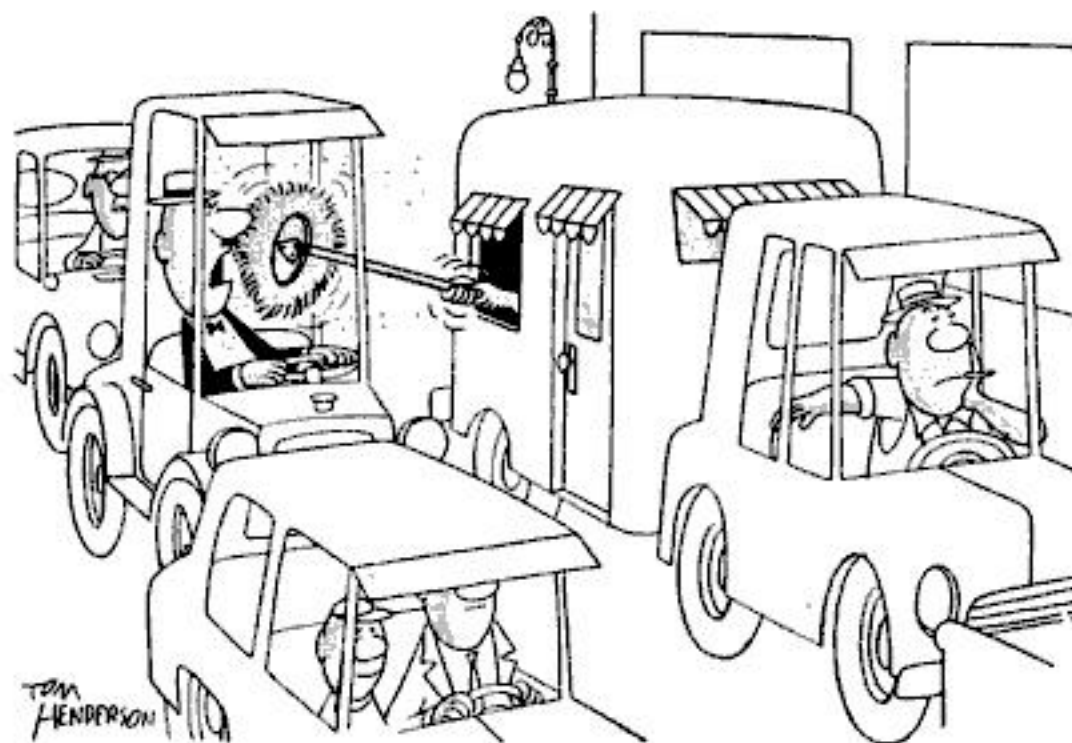
heard me start the engine and said it was out of time. Sort of galloped like the spark was early. Cost me a tune-up."

"How did it sound then?"

"Just the same—the starter dragged, kind of hitching itself around. So I stopped in Delaware. Fellow there put a meter on the starter. It showed a big voltage drop."

"Let's check," said Gus.

Disconnecting the charger, he hooked a voltmeter across the starter while Calladay turned it on. Despite a fresh boost in the apparently sound six-volt battery, the starter ground sluggishly.



"Lady, wouldja kindly watch what you're doing!"

"Voltage trouble?" asked Calladay.

"Looks that way," Gus admitted. "It shows a three-volt drop. Should be less than two. Commutator may be shorting . . ."

Through Gus's coverall sleeve, which lay across the battery as he leaned against the car, seeped an unmistakable warmth.

"How old is this battery cable?"

"Only a week," said Calladay. "Just after I started north, a fellow in a service station showed me the old one was in bad shape. He put on that one."

Gus flashed a light on it.

"That's your trouble, not the starter," he said. "Ever hear of voltage drop?"

Calladay grinned sheepishly. "Not before that fellow mentioned it. But it sounded hep, and I've heard of inadequate wiring, so I thought I'd try it on you."

Gus said nothing.

"I wasn't doing so good down in Florida. Swain is an old friend; he got me his job up here. I'm short of cash and had to make good, so I hated to start by okaying complaints."

There was a brief, awkward silence.

"Now here," said Gus, "your trouble really is voltage drop."

"But you boosted the battery."

"Sure. The voltage is there. But this cable's for 12-volt systems."

"Yeah, I noticed. So it sure ought to carry six in my car."

"Whoa," laughed Gus. "It's the amount of current that must flow through a cable

that determines how big it must be. The starter in your six-volt system needs twice the current a 12-volt one would, and a bigger cable to carry it. That's where voltage drop comes in. Try to push current through a cable that's too small and the extra resistance causes excessive voltage drop. And remember, it's the voltage at the end of the line that counts—battery voltage minus voltage dropped on the way."

"I see," said Calladay. "Did the cold have anything to do with it?"

"This cold snap was just the last straw," said Gus, removing the offending cable. "A cold battery puts out less juice; and to make matters worse, thick oil makes cranking harder."

"Okay," said Calladay. "Now let's go back. Why did you say my starter needed twice as much current as a 12-volt car?"

"Simple multiplication," said Gus. "Electric power, which is what does the work, is voltage times current. With 12 volts, a car needs only half the current to get the same power." Gus grinned. "But don't try to switch your car over piece by piece. It's got to be designed for 12 volts from the beginning."

A brake squeal sounded outside. "There's your company service truck," Gus said. "Hope they fix the compressor. But I'll still charge you for a new cable."

"Fair enough," said Calladay. "I'll just consider it tuition for a course on voltage drop."



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Just connect the ESB ACTIVERter to a battery and you can have 110 AC instantly, anywhere, for many hours. You can plug in portable electric power tools, an electric blanket, electric lights, even a television set! A flick of a switch and the ESB ACTIVERter fast or slow charges 6 or 12 Volt batteries.

Compact, Rugged, Truly Portable

The compactness of the ESB ACTIVERter design makes it possible to have a 12 Volt storage battery, an inverter, and a battery charger all in one self-contained and portable package. One PAK-O-POWER ACTIVERter model provides a source of 110 Volt AC, with an output rating of 500 Watts, in a package the size of a portable picnic cooler! Because solid-state electronic components are used throughout, ACTIVERters are both rugged and lightweight. There are no moving parts, no vibrators.



4 Sizes — from 150 to 500 Watts

MODEL I-152 INVERTER — Inverter only, operates from direct connection to 12 Volt battery or through cigarette lighter socket of cars with 12 Volt systems. Output ratings: Intermittent Use — 150 Watts, 1.5 Amps. AC... Continuous Use — 125 Watts, 1.2 Amps. AC. Shipping Weight: 8 lbs.

MODEL IC-252 ACTIVERter — Inverter-Charger operates from direct connection to 12 Volt battery. Output ratings: Intermittent Use — 250 Watts, 2.3 Amps. AC... Continuous Use — 200 Watts, 1.8 Amps. AC. Shipping Weight: 15 lbs.

MODEL IC-202P PAK-O-POWER — Inverter-Charger with compartment for 12 Volt battery. Completely self-contained unit. Output ratings: Intermittent Use — 250 Watts, 2.3 Amps. AC... Continuous Use — 200 Watts, 1.8 Amps. AC. Shipping Weight less battery: 22 lbs.

MODEL IC-506S PAK-O-POWER — The Multi-Service Inverter-Charger-Car Start unit, with large 12 Volt battery compartment and Car Start leads. Completely self-contained with built-in fast and slow charger — Charging rate: 60 Amps. for 6 Volt, and 40 Amps. for 12 Volt batteries. Output ratings: Intermittent Use — 500 Watts, 4.0 Amps. AC... Continuous Use — 300 Watts, 2.5 Amps. AC. Shipping Weight less battery: 55 lbs.

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Why People Walk in Their Sleep

[Continued from page 128]

strike a match, or hold a flashlight in front of his eyes, he seems not to notice. His hearing is normal, but usually he will not answer questions. If he does talk, his speech is usually incoherent, repetitive, or meaningless. Dr. R. M. Mayon-White of London said in a recent issue of the English journal *The Practitioner* that sleepwalkers, when they do speak, usually ask: "Have you got it?" or "Where is it?"

A sleepwalker's arms, as he moves about, usually move as they would when he is awake. Contrary to the cartoons and the scenes in slapstick movies about sleepwalkers, they do not walk with their arms outstretched.

Should you wake him? Another myth says that it is always dangerous to awaken a sleepwalker. Physicians explain that it is risky only when the walker is discovered in some perilous place, such as a high window. Startling him may make him lose his balance. In any case, it may unduly excite him and make him unable to go to sleep again that night.

"The best thing to do," says Dr. Bruno Gebhard, director of the Cleveland Health Museum, "is to touch the person gently, and speak quietly to him. Tell him where he is. Let him know he is sleepwalking. Then lead him back to bed."

Dr. Gebhard advises parents that if their child has a habit of sleepwalking, as many do, he should be awakened the same gradual way. Also, he says, "Stay with the child for a while after you have him safely under the covers again. Explain sleepwalking to him, but don't go on about it. If you make it sound too important, his subconscious may be tempted to repeat the episode."

When either a child or an adult persists in these nightly prowls, a physician should be consulted. You may need to explore to see if there are any deep underlying causes of his sleepwalking.

Is there a cure? Nearly all cases of sleepwalking can be cured without any prescribed treatment. Says Dr. Gebhard: "The best remedy is for the somnambulist to recognize and understand his own worries and wishes and to talk about them. You try to uncover the basic trouble and reduce or eliminate it."



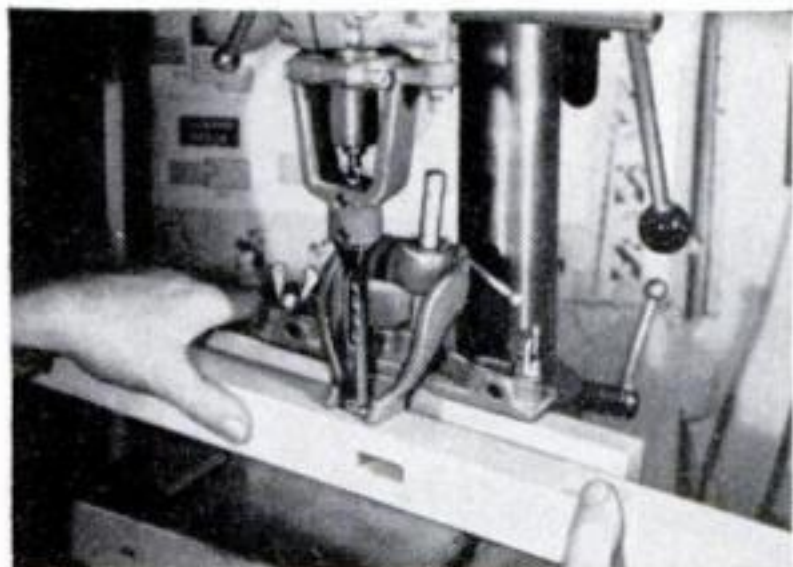
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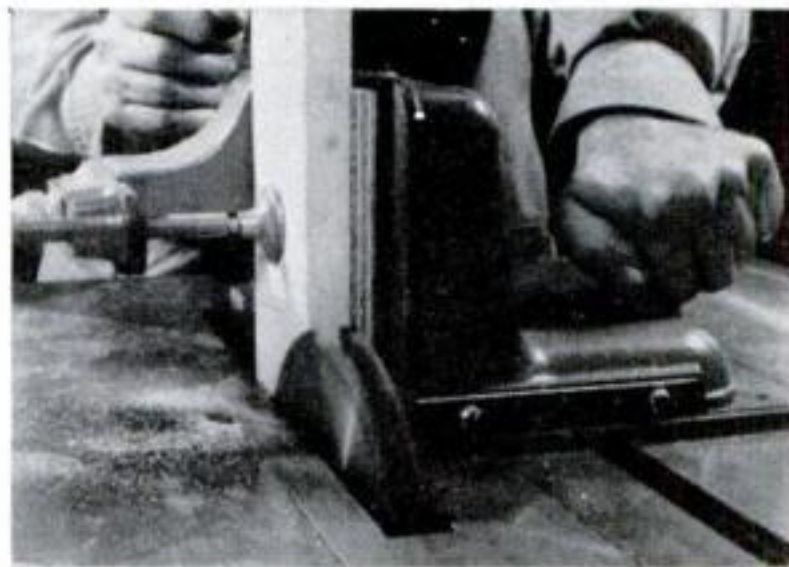
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Why People Walk in Their Sleep

Experts agree that the chances of a sleepwalker harming or killing someone are small. An individual's sense of right and wrong is pretty much the same, it seems, as it is when he is awake. There are stark exceptions—an Englishman who knifed his wife to death, an Arkansas father who fatally beat his four-year-old daughter with a flashlight.

Dr. Edward Podolsky of Brooklyn, N.Y., writing of "somnambulistic homicide" in a journal of psychiatry and neurology, *Diseases of the Nervous System*, tells of a Mount Vernon, N.Y.,

.....
Next Month: Ticklish? Most of us are. One girl nearly lost her fiance because she laughed when he kissed her. His mustache tickled. Read what scientific "tickle tests" reveal about this everyday human reflex—in April PS.
.....

man who shot and killed his wife while he was sleepwalking.

The husband testified that he had not awakened from his sleep until several hours after he had committed the crime. He said that he did not even hear the shot he fired. The doctor said the jury found it hard to believe until medical evidence convinced them that a sleepwalker could sleep through any kind of activity, "however noisy and explosive."

Night rider. Sometimes there is no explaining how tragedy is averted in the sleepwalker's misty world. Take the case of a woman in Berkeley, Calif. She threw back the blankets, pulled on slacks and coat, went to the garage, and drove away in her husband's car. She awoke, beside a freeway, 23 miles from home.

"When I came to, the car was stopped and I was pounding my fists on the dashboard," said Mrs. Albert J. Wollner. "The lights wouldn't work. I suppose I was hitting the dashboard to get them on. It must have been the pain that awakened me."

Science today, despite all of the research and study in sleepwalking, still does not comprehend what is behind all of these curious manifestations.

Shakespeare's doctor, in the tragedy *Macbeth*, probably best summed up the mystery of sleepwalking when he said: "This disease is beyond my practice."

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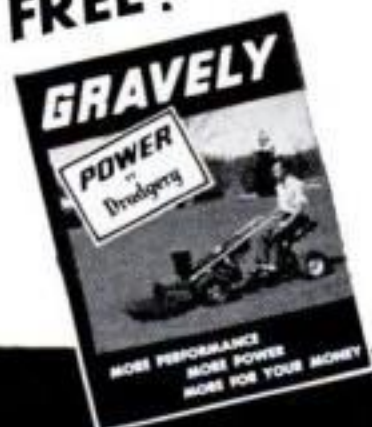
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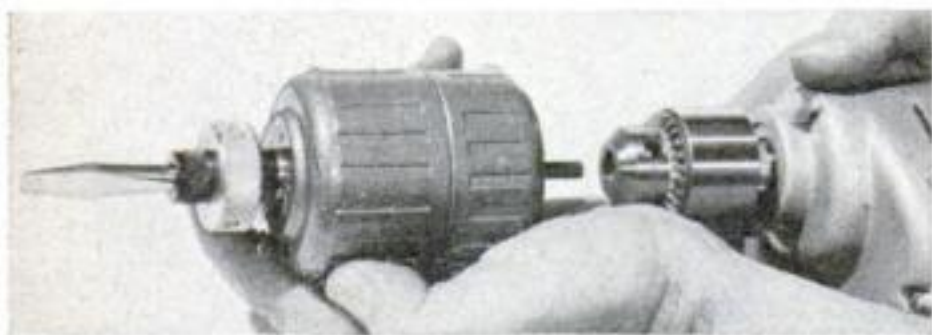
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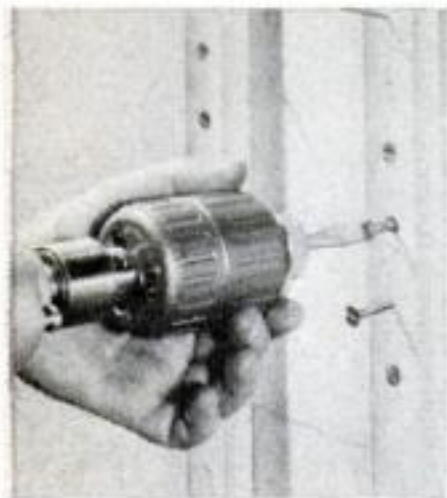
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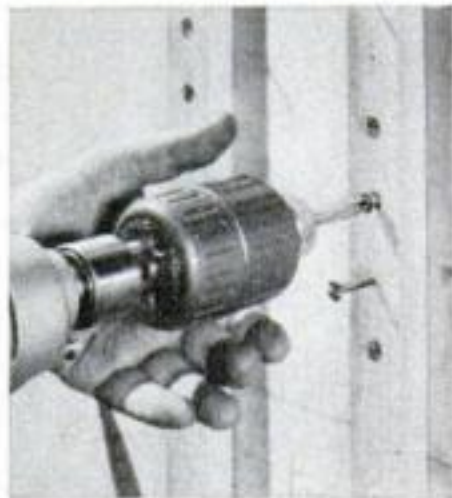
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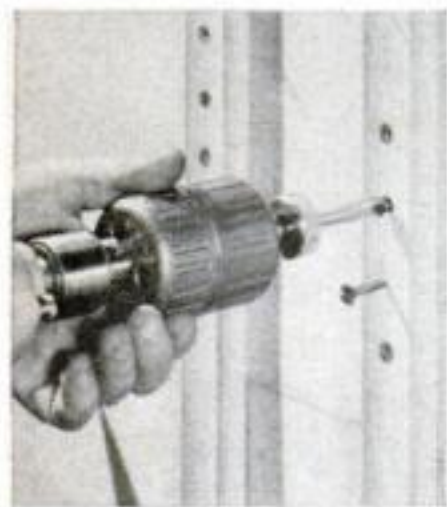


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The Ticklish Job of Air Refueling

[Continued from page 100]

Just keep your wings parallel with the tanker's and do what the lights say."

This time I get in all right, and manage to hang on for a few minutes. As soon as I settle down in contact, the tanker starts pumping fuel, at 600 to 900 gallons per minute. I have to stay hooked up for about six minutes—and those are long minutes.

Penzien is coaching me: "Easy now on those throttles—easy, easy—not so much pitching, you're overcontrolling—just make those corrections smooth—there, that's good position."

Naturally, as soon as he says that I'm in good shape, I go to pieces. I start overcontrolling again and soon get a porpoising action. The boomer can hardly keep up with me: "Up two—up four—down two—down four—disconnect."

I back off to settle down and rest a minute and then drive in again past the end of the boom and into position. The nozzle clunks into the receptacle and somehow I stay in contact for a few more minutes. I ought to have about all of the fuel by now, I think.

But the tanker pilot reports, "You have 20,000 pounds. Ten more to go. Are you ready?"

Penzien continues, "Come on, now, you're too high, get it down—now you're too low—watch it! Don't get so far forward."

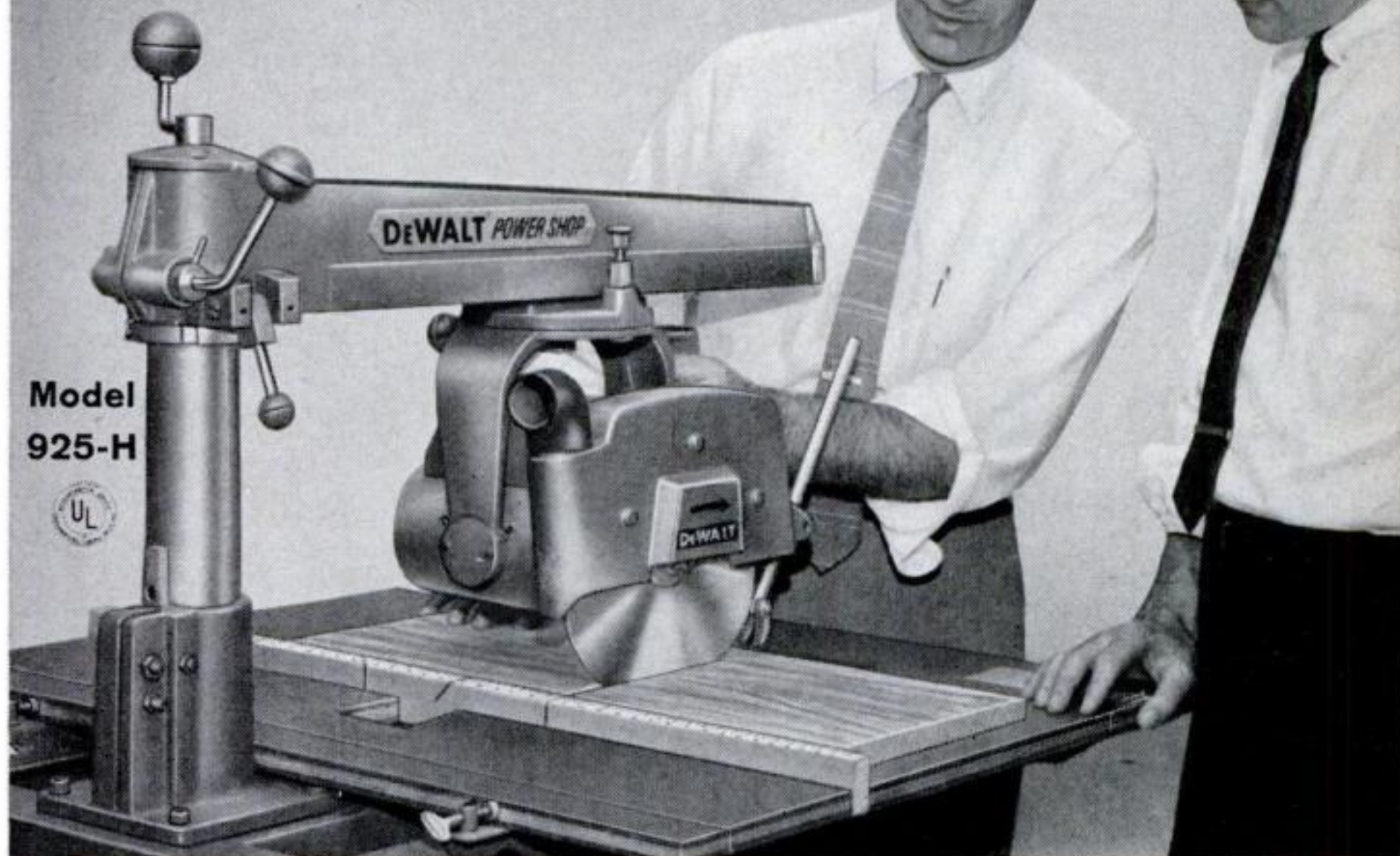
If you go past the forward limit too fast, the boom may not be able to disconnect fast enough to avoid being broken. More than one bomber has landed with a boom planted in its receptacle, and the tanker minus some plumbing.

With my last reserves of strength, I hold the 52 to a draw, and finally the tanker pilot says, "You have your scheduled off-load."

"Roger," I reply. "Disconnect on my count of three—one, two, three." I push my disconnect button and drop down and away from the tanker.

Some day there won't be any more tankers, and air refueling will be a thing of the past. Tomorrow it may be the re-entry-from-space maneuver that the pilot sweats out. But today, the guy hanging on the business end of a refueling boom has one of the toughest jobs in flying.

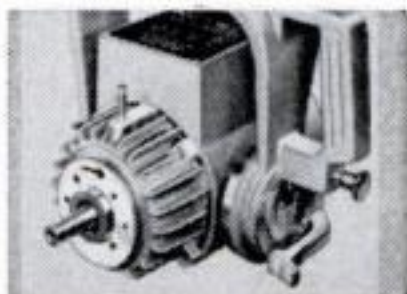
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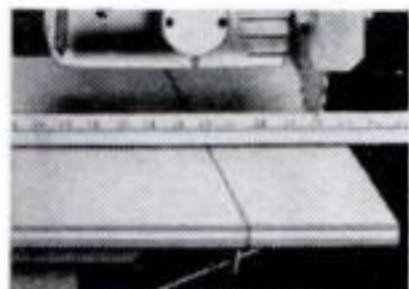
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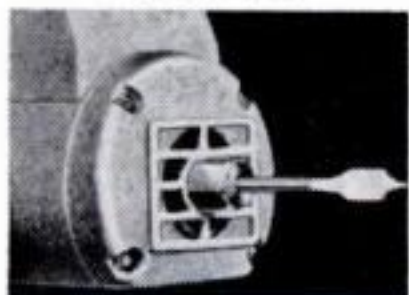
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They Bait Their Nets for Junk

[Continued from page 109]

proached we saw that it measured about 40 by 20 feet.

"When we get a piece too big for our nets, we either secure it alongside or haul it aboard," Noonan told us. "I'm going to haul this baby on deck."

Noonan worked the Driftmaster close to the drift. Then, manipulating levers in the pilot house, he jockeyed the boom over the giant piece of flotsam and encircled it with two wires.

Slowly he eased back on a lever, and the giant mass rose from the water. It was built of 12-by-12 timber and was 5 feet thick in some spots.

"Weighs about 10 tons," said Noonan.

Bagging the limit. With the drift safely secured across the deck, Noonan ordered the second net lowered, and the Driftmaster resumed normal operations. Pretty soon the second net was bulging with drift.

"What do you do now?" I asked.

"You'll see," Noonan said. "We're heading for the incinerator barges."

The trip to the barges took about 20 minutes. En route, Noonan explained that the Army Corps of Engineers has been responsible for keeping New York Harbor clean since 1915. It operates a fleet of four vessels to do the job, but the Driftmaster is the only one specially designed for the work.

About 12:45 p.m. the Driftmaster arrived at the burning barges, one steel and the other concrete. The concrete one had a steel firebox built on deck. There was a layer of sand in the box to insulate it and to absorb some of the residue.

With the Driftmaster alongside, Noonan again worked the pilot-house levers to empty the nets. It took 10 minutes.

Kerosene was sprinkled on the pile, a mass of oil-soaked rags tucked in, and a match struck. Before we were 100 yards away, the fire was burning fiercely.

Then we went back to work, sweeping New York Harbor. When the day was over I asked Noonan if he thought the Driftmaster would ever be put in mothballs.

"Not much chance," he said. "There's more and more drift every year. This puddle jumper"—and he patted the Driftmaster's wheel affectionately—"has her work cut out for years to come."

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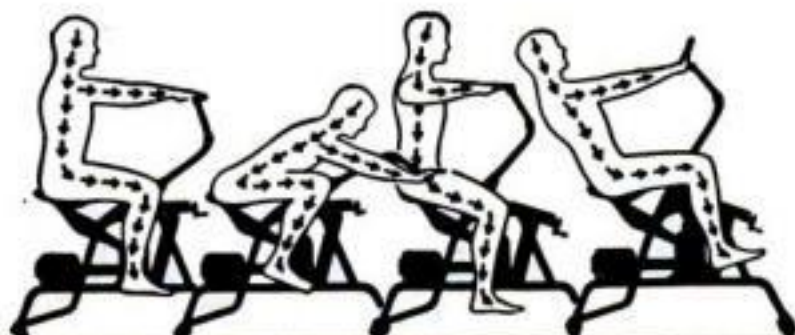
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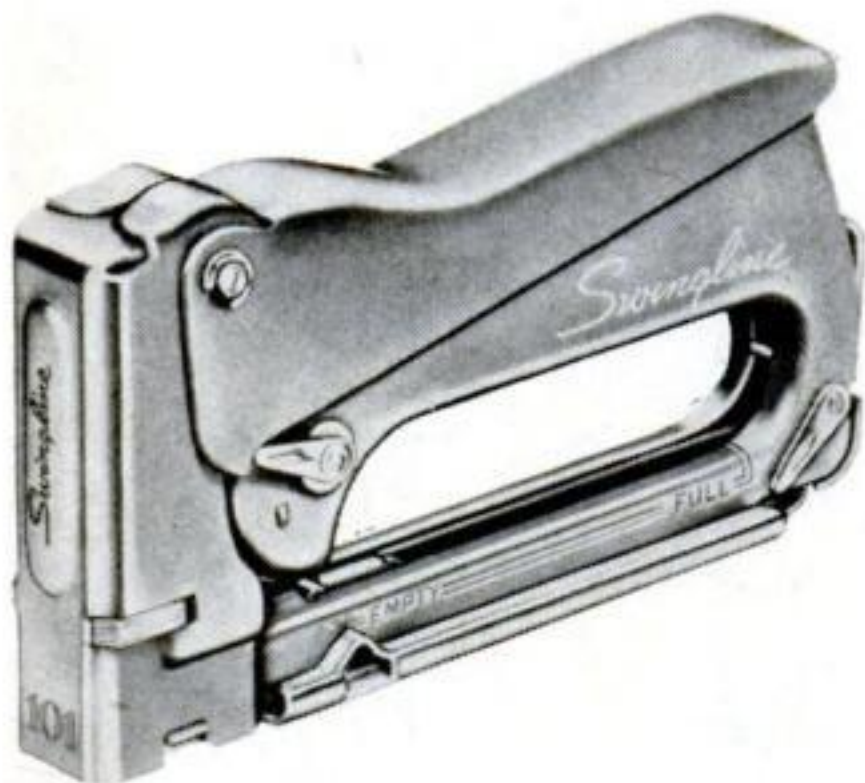
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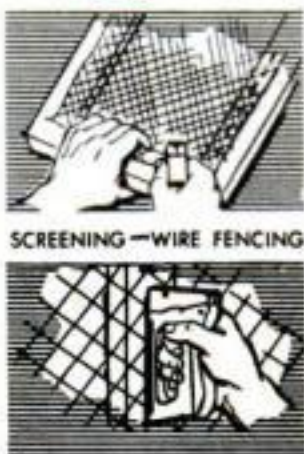
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Catching Drunk Drivers

[Continued from page 63]

wrong-side cuckoo who had been sopping up drinks since afternoon. It had been the same old story: headlights, scream of tires, an explosion of glass, chrome, and dust. One woman died. The other was alive, technically, when they took her from the wreck.

At 12:38 a.m. we passed an inn and heard a racket at the bar. Then we saw two men loitering in shadows near parked cars. Car thieves? Waite pulled off the road and cut his lights.

A burst of singing and shouts from the inn. The lights inside blinked for closing. Then the two men we'd seen before staggered out into the road. They were in bad shape. They began trying to flag cars on the busy road.

Waite was worried. "Somebody," he said, "is going to get hurt." He pushed a button and the green car-to-car light came on. He said into the mike, quietly: "TS18 to TS17. Where are you, please?" We knew Trooper Bernard Peterson in TS16 had just gone north and Walt Trella was up there, too. Jim Jacob was south in TS14, and Jerome Nepiarsky was coming out of Danbury in TS12. TS17, Charley Hyatt, probably was closest.

TS17 answered: "I'm a mile north."

"Got a coupla drunks on the road," Waite said. "Want to come up and get 'em out of here, TS17, before they get hit?"

Hyatt rogered. A moment passed, and we saw his lights. His cruiser stopped right beside us, facing the same way. He called over to the drunks and talked them off the road.

AT 12:52 p.m. we heard new shouting from the inn. Lights blinked again. Suddenly our radio was saying: "Did you see that?" It was Hyatt.

We saw it, all right. The front door of the inn opened and a tall, wiry man in a bright red jacket ran out. Then he fell flat on his face.

Instantly he picked himself up, got in his car, started the motor. Events now happened in split seconds.

The car, a yellow Pontiac from Ohio, shot out backward, skidded to a stop, then came forward. It turned, heeling sharply, and the headlights bored into our car. It was going to ram us.

CONTINUED

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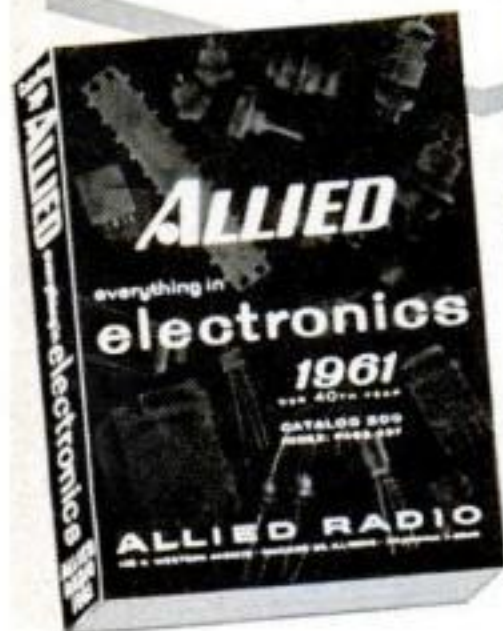
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Catching Drunk Drivers

Then it swung. It was going to ram TS17, instead.

Hyatt had no time to get out. The car came at him, and then, with a humping skid, stopped bumper to bumper with the police car. The driver sat and hammered his horn, trying to blast Hyatt out of the way. Hyatt got out to collar him.

Then the fellow went off the deep end. He backed, turned, and, spitting gravel, blazed off. Way down the road we saw several pairs of lights coming. Waite said, "My God, he's on the wrong side! He's going to hit somebody!" We didn't know it, but the first oncoming car was Walt Trella's.

HYATT ran back to TS17. We didn't wait for him but went out like a Texas tornado. Then we saw a parked car ahead. It was Peterson in TS16, a blue Ford. Waite barked into the mike: "Get him quick, Pete, before he nails somebody! He's a real cuckoo!"

We saw Peterson jump out, flash in hand. The car nearly ran him down. The oncoming headlights were right ahead now. When a crash seemed inevitable, the first car spun out of his way. As we went by we saw Trella in TS13 up on the grassy bank. He whirled and followed us.

More headlights ahead. We had to get between them and the drunk we were chasing. Our red flasher came on and our siren went up about 20 octaves. The bass notes came from that Thunderbird Interceptor. Then for an instant the Pontiac weaved over. Waite saw his chance. We hurled past, cut him off, and skidded.

When the tires stopped howling we had him blocked. The oncoming car, seeing our red flasher, stopped. The cuckoo also stopped and lurched out, leaving his car rolling. Walt Trella ran up and set the brake. The driver fell flat—this time on his back. The troopers picked him up. But first, staring up into their flashlights, he giggled, "It's a good thing I'm not drunk." Nobody laughed.

On the way to jail this man wanted to fight. His blood tested .24 of one percent alcohol; he was "stoned." Before we resumed patrol we stopped in a diner for coffee. Nobody said much. We all realized that, besides gambling his own life, this

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Catching Drunk Drivers

fellow had come awfully close to killing several people that night.

EACH car in the patrol carried a quiet little psychological weapon: a neat package of printed notices. Each "DD" arrested got one—telling him where Alcoholics Anonymous meets and when.

This was a shock to some, a help to others. "A lot of these drivers are real alcoholics," says Commissioner Mulcahy. "The others get something to think about."

Mulcahy has other weapons up his sleeve against cuckoos. One is to warn roadside taverns to quit serving drunks. Reputable places, he says, are beginning to cooperate.

THE drunk tests for which we were equipped are not mandatory. But most drivers arrested as "DDs" took them; sometimes they get a man off the hook by proving he isn't drunk even though he seems to be. Samples—blood or urine—are checked out in a lab before trial. Anyone testing .15 of one percent alcohol in the blood is legally drunk in Connecticut. Over .15 is, in police talk, "stoned." And from .28 to .30 is "dead." It is the "stoned" and "dead" drivers, police say, who are the cuckoos.

Other patrols carry such kits—and lately instant-test breath balloons have been added. But the satellite patrols use them most of all. There's a reason for this. Ordinary patrols are so busy with miscellaneous duties that they can't put in much time on any one of them. But Mulcahy has seen to it that his satellite patrols have only one job: making traffic safer.

Lately Vermont and New Jersey have tried satellite patrols; other states may follow suit.

What does the public think? The night we stopped the 110-mile-an-hour Oldsmobile, two local citizens walked over to the scene. "Thanks," one of them told the troopers. "A guy like that killed one of our local boys and injured his girl a few nights ago."

One night when TS West pulled another cuckoo off the road, a station wagon filled with people drove up. "Gosh, we're glad you got him," said the driver. "He nearly got us—and he sure would have hit somebody."

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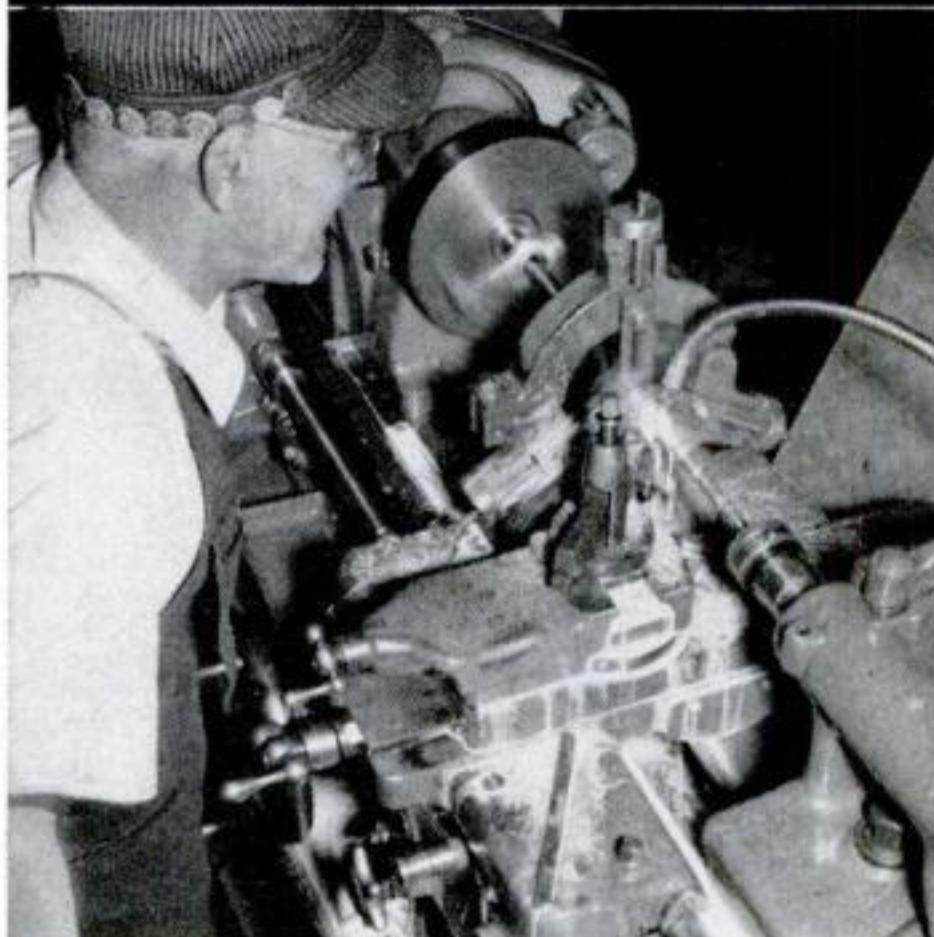
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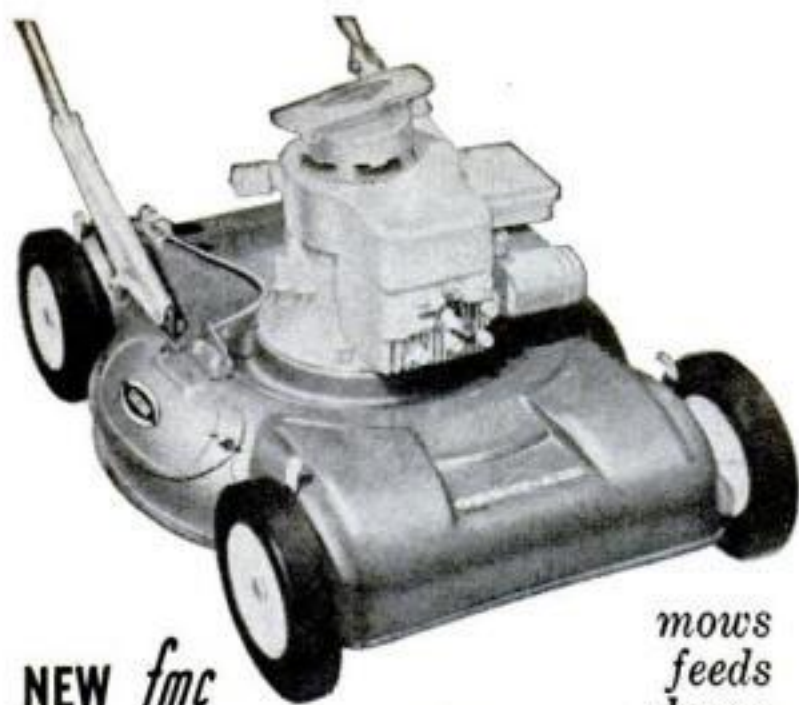
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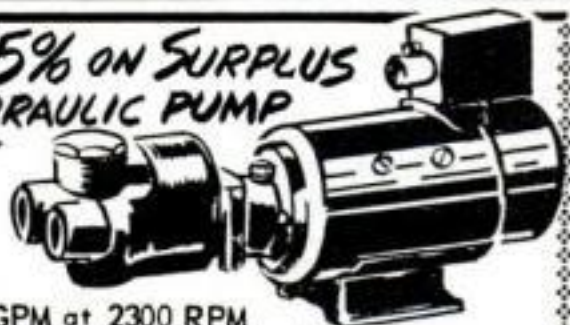
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Giant Kettle Brews Fresh Water

[Continued from page 68]

around 90 and has flashed its last. It is also twice as salty as it was when it began its journey through the evaporators.

Journey's end. You might suppose that all this super-salty water would be dumped. Instead, to make the most efficient use of heat, some will be mixed with incoming sea water and recirculated. The rest will be discharged into the ocean at a point on the shore line 350 feet south of the intake. The prevailing current flows southward there.

Pure water from the evaporator troughs will be aerated and pumped to a nearby storage tank. San Diego will draw on that tank through a 3 1/2-mile pipeline and probably mix the purified salt water with its normal supply.

Fluor's engineers predict that the Pt. Loma plant will produce 10-11 pounds of fresh water for a pound of steam. They are convinced that the multistage flash-evaporation process makes the most efficient use of heat in converting sea water to fresh. Furthermore, it can be easily expanded to very large size, which is not true of many other conversion processes. This last point is important: The bigger the conversion plant, the lower the cost of its product, they say.

Turning on the heat. Fluor's studies have shown them that using a nuclear reactor to produce low-pressure steam for their favorite conversion process will become the most economical heating method when the plant is big enough to produce 50 million gallons of fresh water per day. And as plant capacity rises above that level, the cost of nuclear heat goes down rapidly, the engineers report.

In making cost studies for a multistage flash-evaporation plant that would turn out 130 million gallons of pure water daily, they estimated that to produce its steam by natural-gas heat would consume six percent of all the natural gas now burned in southern California. This drastic demand would so disrupt the fossil-fuel market there that nuclear heat is the only feasible substitute. Its importance to big-volume production of fresh water from the sea becomes even clearer when one learns that 130 million gallons per day is only seven percent of the water southern California now uses.

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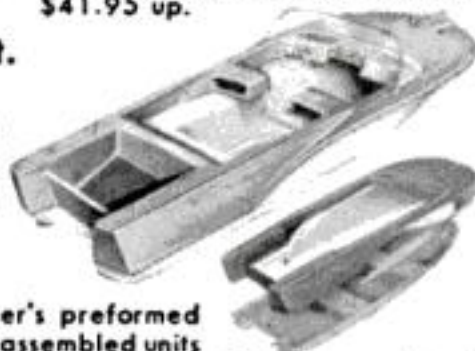


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Giant Kettle Brews Fresh Water

sea-water conversion plant at Pt. Loma, the U. S. Office of Saline Water is not depending on it alone to solve the water problems of future Americans.

And more to come. There are four other demonstration plants in the works. Each will utilize a different process, all of them promising.

One being built at Freeport, Tex., on the Gulf of Mexico, will turn sea water to fresh by a means somewhat similar to that used at Pt. Loma. It is called the long-tube-vertical, multiple-effect distillation process. The Freeport plant will also produce 1,000,000 gallons of fresh water per day. In addition, a Dow Chemical facility next door plans to extract magnesium from the residual brine.

Multiple-effect distillation, though not of the long-tube-vertical type, is already proving its merits in the largest commercial water-converting plant in the world. It is on the once-parched little island of Aruba. Every day, it extracts 2,700,000 gallons of fresh water from the Caribbean Sea, plenty for the island's 55,000 inhabitants.

In inland regions that lie over natural reservoirs of brackish water, less briny than the sea but undrinkable, other desalting processes will be tested.

Straining out salt. At Webster, S. D., there's to be a 250,000-gallon-per-day conversion plant that uses electrical energy to move salt through membranes and separate it from water. This process already supplies the town of Coalinga, Calif., with all its drinking water [PS, Aug. '59].

At Roswell, N. M., another region of brackish water, a fourth demonstration plant will produce 250,000 gallons daily of pure water by means of a vapor-compression process.

A fifth method of attacking the problem is a freezing process, by means of which pure ice crystals are formed by congealing brine. As yet, the plant site and capacity have not been announced.

Of course, scientists have long yearned to use the free heat of the sun to distill sea water. This works pretty well in small installations. It becomes utterly unfeasible for big ones. A solar still large enough to produce as much water as southern Californians now consume each day would cover 400 square miles.

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10,000 Miles in a Lancer

[Continued from page 82]

engine make sense only for people with a compulsive need for jazzy performance. But it is a very eager darter-through-traffic, a storming passer.

Allaway: What you get for your gas money is very flashy performance—spine-stiffening acceleration, and extremely aggressive passing ability, even without kicking the transmission down.

Rowsome: The 3.9 axle handicaps the top speed.

Mann: Yes, it gets shrill around 70 m.p.h. That's not sufficient for turnpike driving. You should have something in reserve.

Markovich: Seventy? I got 85.

Fermoye: Only 85? The top speed of the car was a true 87 miles an hour. We clocked it on the Daytona Speedway with three aboard.

Rowsome: After 4,000 miles more to loosen up, she made about 92 true.

Design and Construction

Lees: The transmission's initial engagement, in either forward or reverse, is a convulsive clunk.

Allaway: I found that the rear roof overhang served as an airfoil that swirled muck over the back window. When the going was messy, it smeared over quickly.

Rowsome: The body seemed a little bit limber. It racks slightly when you tackle rough, cow-pasture roads. And door slams cause the long, ribbed top to bulge and tremble.

Lees: I couldn't figure out the purpose of two parking brakes.

Rowsome: That screwy park lock didn't seem to work, at least under roll-back loads. The pedal-type parking brake was fine, though it released with a crash.

Mann: I've been waiting for Markovich to get in his say about the transmission. For me, in getting away from a light it grabbed so abruptly that you could snap your passengers' vertebrae. Furthermore, the transmission had all sorts of impolite noises as it marched up through the gears. And it wouldn't upshift when cold. Alex?

Markovich: I guess it just fell to me to be driving the Lancer when the transmission finally went kaput. The car lurched and bucked in first gear, although it seemed okay in second and third. But

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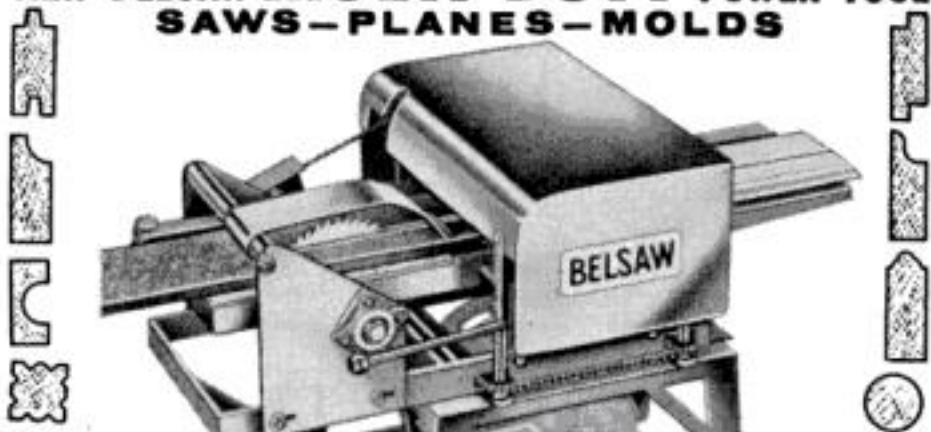
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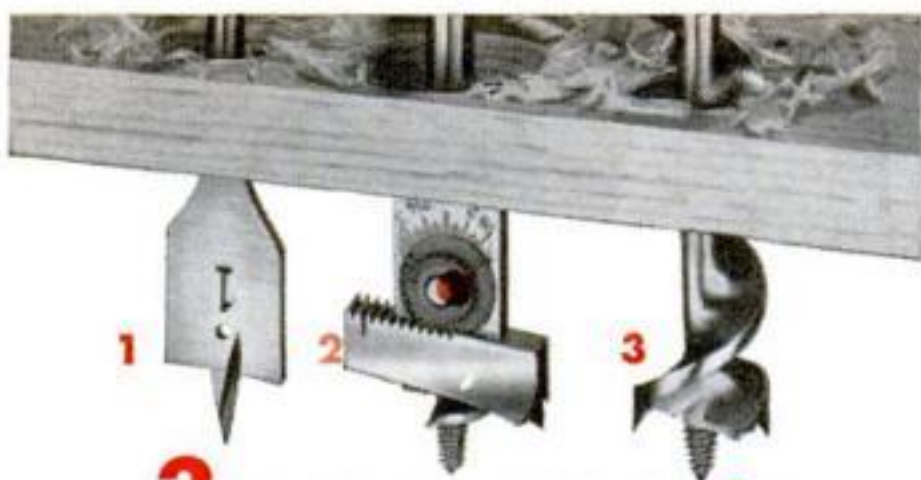
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BASEMENT DOOR

10,000 Miles in a Lancer

reverse went out completely. I had to take it in for repair.

Rowsome: The trouble was a sticking rear servo, which burned out the bands. They fixed it under the warranty. But considering how we were belting the poor thing, I don't know that it was a meaningful failure.

Safety and Comfort Features

Lees: Over-the-hood visibility is exceptionally good.

Fermoyle: For my taste, the leading edge of the front seat is a bit high and hard, and has a welt running across it. It gave me cramps in the leg.

Mann: I found the interior comfort excellent. The heater is magnificent.

Allaway: Anybody notice the ash tray? It's a long arm's length from the driver, and the ashes spill out the sides.

Rowsome: We figured that the guy who designed it doesn't smoke. And the tailgate crank is a mechanical I.Q. test the first time you try it.

Lees: The turn signal should be more audible. And that sharp triangle that tops the rear of the front door had me lifting my hand to protect my Adam's apple.

Markovich: I'm much less critical in this department. The instruments were well placed. I was grateful for the variable-speed electric wipers. There was plenty of luggage space. I found practically no wind noise, regardless of the window opening.

In Conclusion

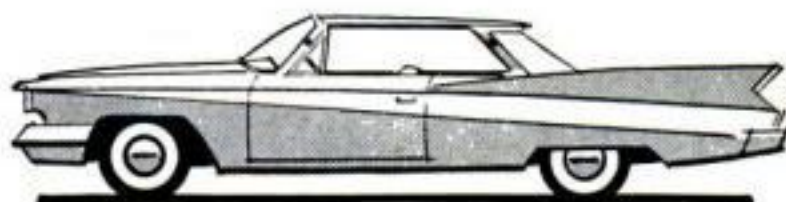
Allaway: I think we might fairly say, because of bad breaks in weather, that we gave this car the toughest run of any of the six compacts we've driven 10,000 miles and reported on. All in all, the Lancer came through fine.

Mann: It's definitely superior—as we equipped it—to the other compacts I've driven.

Rowsome: A very ingratiating vehicle. Anything that goes like this one is entitled to have a bum ash tray.

NEXT MONTH: Some look like a pile of junk; others are slick as a Jag saloon. Some are for show; others will hit 200 m.p.h. For ingenious machinery, read "Cars Detroit Never Built"—a roundup of remarkable hot rods—in April PS.

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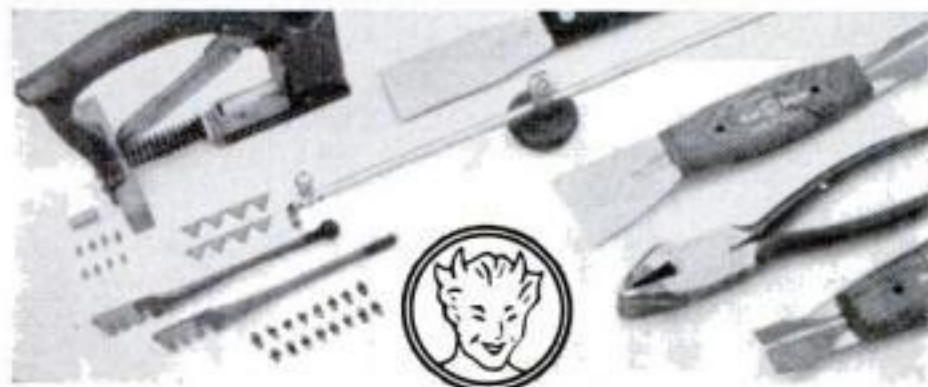
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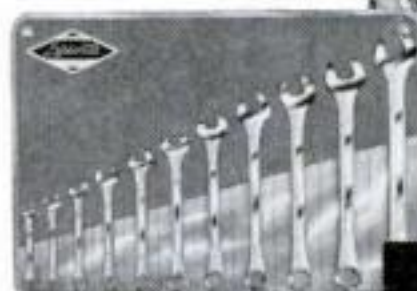
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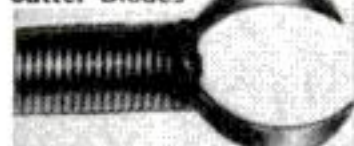
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Answers to PS Puzzlers

on 18 and 20

Sports meet. No. If he averaged 30 m.p.h. on the first lap his rate was a half a mile a minute. It would have taken him two minutes—all his allotted time—to complete that first mile lap.

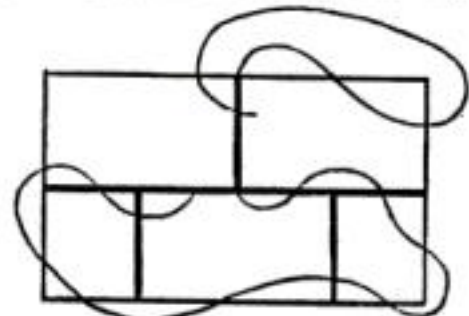
Crosstown traffic. It's 12 m.p.h. "Average" rate equals the total distance divided by the total time. Figure this way:

Let d = the distance from bridge to office
Then time out = $\frac{d}{10}$ and time back = $\frac{d}{15}$

The total time = $\frac{d}{10} + \frac{d}{15} = \frac{25d}{150} = \frac{d}{6}$

The total distance = $2d$. Dividing $2d$ by $d/6$ gives 12 m.p.h.

Unicursal poser. If you stay on the line, you're not crossing it.



Defective nails. The number of ways you can pick 10 items out of any collection of 100 (with no replacement as you go) is simply: $100 \times 99 \times 98 \times \dots \times 91$.

But in collections of look-alike objects like nails you don't care in what order the batches come out. In other words you'll want to consider an assortment containing nails 3, 5, 9, 15, 23, 18, 4, 10, 99, and 16 as the same as another batch which came out 15, 99, 23, 10, 4, 18, 5, 16, 3, and 9. To eliminate these duplicates you divide the original total by the number of ways of ordering 10 items: $10 \times 9 \times 8 \times \dots \times 1$.

The good nails form a subset of the whole collection in which you have only 90 nails to choose from at the start, so your total combinations (again dividing through by the ordering factor) is:

$90 \times 89 \times 88 \times \dots \times 81$

$10 \times 9 \times 8 \times \dots \times 1$

The final probability is simply good-nail combinations over the total combinations. In making that fraction the ordering factor cancels out and you get simply:

$90 \times 89 \times 88 \times \dots \times 81$

$100 \times 99 \times 98 \times \dots \times 91$

This is approximately 0.330476. That means that the chances of getting no defectives in 10 nails are a bit less than a third.

Counterfeit Coin: Coins minted in the time of George I would not have borne the numeral. George "I" doesn't exist until there's a George II.

Nines and sevens: $99 \frac{9}{9} = 100$. As for the

sevens, any variation on this theme will work: $\frac{77}{77}$. And of course they don't have to

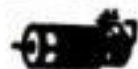
be 7s either.

Homer's fury: It seems the fishermen were talking about fleas, not fish.

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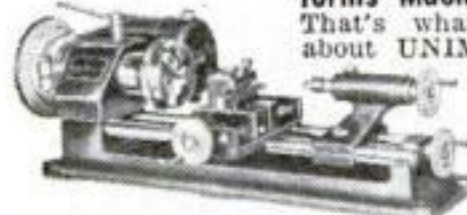
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USE THIS HANDY INDEX TO FIND WHAT YOU WANT

Advertising, Agencies for Advertisers . . .	53
Agents Wanted . . .	43
Antiques, Relics & Indian Goods . . .	29
Authors Service . . .	52
Auto Supplies & Equipment . . .	2
Auto Trailers . . .	3
Automobiles & Midget Cars . . .	1
Aviation . . .	5
Batteries, Generators, Etc. . .	6
Boats, Outboard Motors . . .	11
Body-Building Courses, Jiu Jitsu, Etc. . .	12
Books & Magazines . . .	23
Business Opportunities . . .	37
Business Service, Information, Name Lists . . .	50
Buy It Wholesale . . .	38A
Cameras, Photo Supplies . . .	34
Camping Equipment & Tents . . .	16
Cartooning, Sign Painting, Chalk Talks . . .	54
Coins & Currency . . .	26
Color Photo Finishing . . .	32A
Contests . . .	46
Detectives . . .	47
Diving Equipment & Training . . .	15A
Do-It-Yourself . . .	66
Dogs, Birds, Hamsters & Pets . . .	17
Earthworms, Crickets, Frogs . . .	18
Educational & Instruction . . .	45
Electrical Supplies & Equipment . . .	7
Employment Information . . .	42
Engineering Services . . .	60A
Engines, Motors, Etc. . .	10
Farms, Other Real Estate . . .	19
Field Glasses, Telescopes . . .	14
For Inventors . . .	60
For Sale Miscellaneous . . .	71
For the Home . . .	69
Formulas, Plans, Etc. . .	39
Government Surplus . . .	11A
High-grade Salesmen . . .	44
Hobbies, Collections . . .	31
Home Craftsman . . .	65
Hypnotism . . .	24
Import-Export . . .	38B
Inventions Wanted . . .	61
Jokes, Games, Novelties, Etc. . .	24A
Language Outfits . . .	48
Loans By Mail . . .	80B
Machinery, Tool Supplies, Etc. . .	9
Magic Tricks, Puzzles, Etc. . .	25
Minerals & Precious Stones . . .	30
Miscellaneous . . .	79
Models, Model Supplies . . .	64
Money-making Opportunities . . .	38
Motion Pictures & Color Slides . . .	33
Motorcycles, Bicycles & Supplies . . .	4
Musical Instruments and Song Writers . . .	35
Of Interest To Women . . .	70
Old Gold, Jewelry, Watches . . .	67
Patent Attorneys . . .	59
Personal . . .	80
Phonograph Records . . .	35A
Photo Finishing, Photocopies, Etc. . .	32
Plastics . . .	40
Poultry & Supplies . . .	21
Printing, Multigraphing, Etc. . .	57
Printing Outfits, Supplies . . .	58
Profitable Occupations . . .	22
Radio, TV, Electronics, Hi-Fi . . .	36
Remailing Service . . .	80A
Rubber Stamps & Office Supplies . . .	56
Science & Chemistry . . .	41
Sporting Goods, Guns, Fishing Tackle, Etc. . .	15
Stainless Steel Tanks . . .	9C
Stamp Collecting . . .	28
Swap . . .	79B
Tobacco & Pipes . . .	68
Treasure Finders & Geiger Counters . . .	77
Trees, Shrubs, Roots & Herbs . . .	20
Typewriters & Office Machines . . .	55
Wanted to Buy . . .	72
Watch Repairing . . .	78
Welding, Soldering . . .	8

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<input type="checkbox"/> Air Conditioning
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<input type="checkbox"/> Arch. Drawing and Designing
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<input type="checkbox"/> General Chemistry | <input type="checkbox"/> Oil Field Technology
<input type="checkbox"/> Pulp and Paper Making

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<input type="checkbox"/> Construction Engineering
<input type="checkbox"/> Highway Engineering
<input type="checkbox"/> Professional Engineer (Civil)
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<input type="checkbox"/> Sanitary Engineer
<input type="checkbox"/> Sewage Plant Operator
<input type="checkbox"/> Structural Engineering
<input type="checkbox"/> Surveying and Mapping
<input type="checkbox"/> Water Works Operator

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<input type="checkbox"/> Architectural Drafting
<input type="checkbox"/> Drafting & Machine Design
<input type="checkbox"/> Electrical Drafting
<input type="checkbox"/> Electrical Engineer Drafting
<input type="checkbox"/> Industrial Piping Drafting
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ELECTRICAL
<input type="checkbox"/> Electrical Appliance Servicing
<input type="checkbox"/> Electrical Engineering | <input type="checkbox"/> Electric Motor Repairman
<input type="checkbox"/> Elec. Engr. Technician
<input type="checkbox"/> Elec. Light and Power
<input type="checkbox"/> Practical Electrician
<input type="checkbox"/> Practical Lineman
<input type="checkbox"/> Professional Engineer

HIGH SCHOOL
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<input type="checkbox"/> High School Diploma
<input type="checkbox"/> High School General
<input type="checkbox"/> H. S. College Prep. (Eng'r'g & Science)
<input type="checkbox"/> High School Math
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<input type="checkbox"/> Industrial Instrumentation | <input type="checkbox"/> Industrial Safety
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<input type="checkbox"/> Mechanical Engineering
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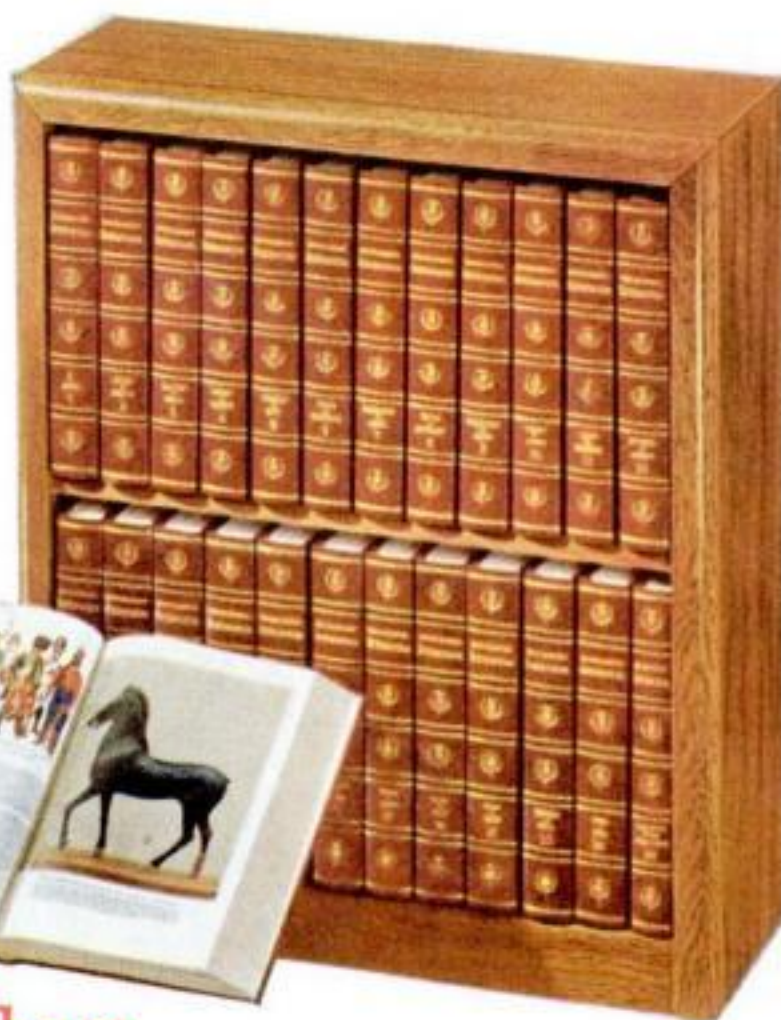
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